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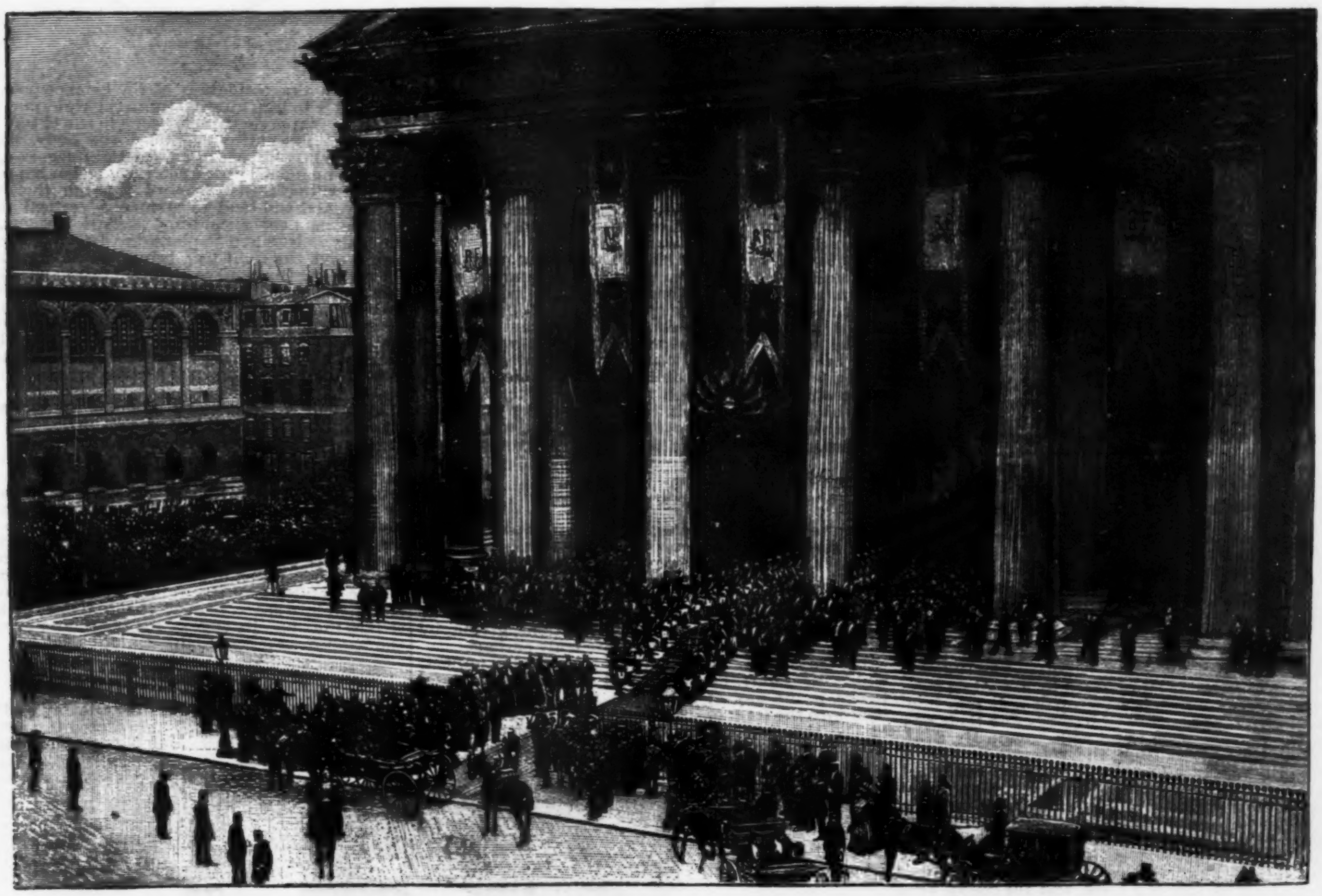
THE CENTENARY OF THE FRENCH REPUBLIC.

The one hundredth anniversary of the foundation of the French republic was celebrated in Paris, in September last, by a most elaborate *fete*, which included a magnificent procession of the same general character as that witnessed in New York in the early part of October. The floats were the finest ever exhibited, one reaching as high as the third-story window. The strains of the "Marseillaise" were constantly heard, and the boulevards were crowded until a late hour to watch the illumination.

The official portion of the ceremony was enacted in the Pantheon, which was appropriately decorated with flags, the tricolor predominating. The speeches, though not very brilliant, were warmly applauded. We illustrate herewith the Pantheon, and for these illustrations we are indebted to *L'Illustration*.

The Pantheon is located on the left bank of the Seine, and is near the Sorbonne and other institutions of learning. It is supposed to occupy the site of the tomb of St. Genevieve, the patron saint of Paris. The present structure was built by Soufflot, and was completed in 1790. In 1791 the Convention resolved to convert it into a memorial temple, calling it the Pantheon, instead of the Church of St. Genevieve, and they placed upon it the following inscription: "*Aux grands hommes la patrie reconnaissante.*" In 1851 the name of the edifice was again changed to its original form, but the popular name has always been retained. The building is in the form of a Greek cross, and is 363 feet long by 276 feet wide. The beautiful dome has been one of the landmarks of Paris for a century, and is 272 feet in height. The tympanum contains a fine group by David d'Angers, the principal figure being 16 feet high. The interior is being decorated with mural paintings by the best artists in France. The paintings already completed are by Puvis de Chavannes, Cabanel, Gerome, Meissonier and Bonnat. In 1885 the edifice was again turned into a temple of glory, and forms the Westminster Abbey of France. Augustus Hare pithily remarks that the building was taken away from St. Genevieve to be given to Victor Hugo, who is buried in the vaults below. The Pantheon was the original burial place of Voltaire and Rousseau, but their bodies were removed secretly, for political reasons. The Pantheon has always been the center of a hotbed of revolution, and formed one of the strongholds of the insurgents in the revolution of 1848 and of the Commune in 1871.

The Pantheon bears the marks of time very lightly, and its white stone is as fresh and white to-day as when it was erected. The building is in the renaissance style of architecture, and is considered by Fergusson to be the third finest renaissance church in Europe, which is no small praise. In front is a portico of fourteen Corinthian columns 60 feet in height, the portico being consequently one of the finest of modern times. The walls are very plain, with the exception of the paintings referred to, the windows being very high up, a serious defect. The dome is chaste and elegant, but is hardly equal to Wren's masterpiece, St. Paul's, in London. The interior details are almost beyond criticism, if it were not for the mode of introducing the four supports for the dome, which was unfortunately rendered necessary in 1806 by reason of faulty construction. The arrangement of windows mentioned above is not calculated to give the dim. religious light. but now that the building is no longer used as a church, this is perhaps an advantage, as it gives the building an air of cheerfulness and permits the paintings to be seen to good advantage. The interior of the Pantheon is considered by many to be the most beautiful interior of any modern church of classical design.



PORTICO OF THE PANTHEON, PARIS—CENTENNIAL CELEBRATION OF THE FRENCH REPUBLIC.

THE NATIONAL LIBRARY AT WASHINGTON.

An underground cable road will connect the new library of Congress with the Capitol. It will be on a Liliputian scale, and the little cars run upon it will carry only books as passengers. So rapid and effective will this method of communication be that Congressmen will be able to procure at the briefest notice volumes that are needed offhand for reference or for use in debate. From a station situated midway between House and Senate orders will be telegraphed or otherwise swiftly sent, and the books on arrival be distributed by messengers. This will be a very different affair from the famous "hole in the ground" which was made seventeen years ago to connect the Capitol with the Government Printing Office by a gigantic pneumatic tube big enough for a man to be whisked through. It was intended for conveying public documents, but the $15,000 spent on it was wasted, inasmuch as it never worked, and it is now used merely as a conduit for telephone wires.

There is no library building in the world that at all compares with the one now being erected by Uncle Sam. Novel mechanical devices will constitute one of its most interesting features. Improvements of the kind have never been thought of abroad, where the great book collections are usually so managed that their treasures are to a great extent unavailable. In the library of Congress the volumes will be handled almost entirely by machinery. Orders will be sent to the book stacks and books brought from them to the desk for distribution by trays suspended from endless chains, the latter being made to travel by means of an engine in the basement. The mechanism will be noiseless and invisible also, the carriers going beneath the floor of the great central reading room to and fro between the librarian's desk and the book stacks. Every arriving tray will dump itself automatically at the desk. Likewise, in taking volumes back each tray will spill its contents of its own accord at a certain tier. For example, if a book belongs on tier 7 the desk attendant waits until the carrier marked No. 7 comes along and puts the volume on it as it passes. When it gets to tier 7 the book is spilled out by the action of a peg and catch, and the person in charge of that tier puts it away on its proper shelf.

When one learns that there are 650,000 bound volumes in the library of Congress, the mind does not grasp the fact with very clear comprehension. It is easier to absorb the idea when it is explained that this number of books, placed side by side as on a shelf, would stretch eleven miles. But the new building was not planned to accommodate only so many, the obvious expectation being that the great collection will grow enormously through centuries to come. Adjoining the central rotunda are two structures which might be compared to gigantic honeycombs, made wholly of iron instead of wax, and designed to hold not nectar, but knowledge. These are called "book stacks," and each of the pair will contain 800,000 volumes. Each of them is 65 feet high, 112 feet long, 45 feet wide, and has nine stories. On the iron shelves, made gridiron fashion, the books will be placed back to back, with just enough room between the bookcases to afford narrow passageways. Thus they will have plenty of fresh air, which is as necessary to books as it is to human beings. Books must have ventilation, else they will rot, and they have to be kept cool. Heat makes them decay, and bad air causes mould. Books stored by this stack system, which is a comparatively new invention, cannot possibly be burned. If set afire,

nothing else combustible being at hand, they merely smoulder.

However, 1,000,000 volumes do not by any means represent the capacity of the building. It is anticipated that the library of Congress will be the biggest in the world some day, and provision has been made in the construction of the edifice for accommodating 5,000,000 books. All binding will be done on the premises—an item which costs $6,000 annually. There will be plenty of room also for the copyright division, which requires great space for the filing away of all publications, etc., on which copyrights are granted. Copyrights are issued for a good many things besides books, periodicals, and pamphlets. They are given for new pieces of music, engravings, chromos, and even puzzles and games. The games and puzzles are not themselves subject to copyright, but the directions for them are so, being printed matter. Very commonly the manufacturers, though there is no need that they should do so, send in the playthings together with the descriptions—building blocks, chopped up animals, parlor billiard tables, or what not—and they are duly stored. Uncle Sam has enough of such articles in the Capitol at present to stock several toy shops for next Christmas.

Not a little of the printed matter submitted for copyrighting is immoral, and so unfit for publication as to render it liable to seizure under the laws. But, oddly enough, the librarian of Congress has no discretion in this regard, and he is compelled to grant the copyright in every instance, so long as the material is original. A common fraud attempted is the request for a copyright on an old book published under a new title. In order to guard against this the assistants in charge of the copyright business must be familiar with everything that has been issued from the press. Obviously this is not wholly possible, but it is wonderful how near they come to it, so that it is very rare for such a cheat to pass undiscovered. People offer many things for copyrighting which do not come legally within the range of that institution. Recently dozens of applications have been made for copyrights on campaign badges. The most interesting was a miniature diaper with a gold safety pin stuck through it, inscribed with the words, "Vote for my Papa. Baby Ruth." The applicant was referred to the Patent Office.

Every great library has its skeleton—that is to say, a collection of books unfit for general perusal, which are hidden away in some corner. Unfortunately there are many works of this description which are classical, and to destroy them would be regarded by all bibliophiles as an atrocious act of vandalism. Such volumes are kept by Librarian Spofford in a little room by themselves, and none of them can be obtained without his special permission. In this curious assemblage novels of a century ago bear a conspicuous part. Their contents afford a vivid conception of the improvement in morals and refinement of speech which has marked the last one hundred years. It seems surprising to find in the *Bon Ton Magazine*, a London society periodical of polite fiction printed in 1794, a publication so vile as to both text and pictures as to be quite indescribable. It is to be lamented that there has grown up within the last decade an entirely new class of disreputable novels in paper covers, the multiplication of which affords a profitable business for unprincipled publishers in New York, Boston and Chicago. They are printed in series and one of them on a book stall the other day was labeled "575th thousand!"

There is one very immoral work in the library of Congress which it has not been thought worth while to hide away, because it is printed in Chinese. It is a famous Oriental classic, and the title of it is "Kin Ping Mei." It gives a satirical picture of the dissolute manners of the age in which it was written, somewhat after the style of Juvenal, but the remarkable thing about it is that it is a double entendre from beginning to end. As perused with the eye it is perfectly proper and unobjectionable in its subject matter; but, read aloud, its entire meaning appears altered, and it is a string of abominations all the way through. Such a thing would only be possible with a language like Chinese, in which every word is represented by a distinct sign, though the whole speech is made up of only four hundred sounds. A good many odd things find their way into a big library. One small collection in Mr. Spofford's charge is kept by itself, the volumes composing it being printed on wall paper. They were published in the South during the war, when paper was a scarce article. A pair of wooden decoy ducks on top of a stack of books seem rather out of place, but they are accounted for by the circumstance that in a catalogue of a collection purchased some time ago the words "Two Decoy Ducks" appeared at the end. This was mistaken for the title of a book, and the ducks were ordered to be sent to Washington with the rest.

The plan of the new library of Congress is copied after that of the British Museum, in respect to having the reading room in the middle, with the book stacks around it. Mr. Spofford will sit at an elevated desk in the center of the big rotunda, so as to overlook everything and keep an eye on the readers. There will be space for 3,000 people, seated at desks arranged in concentric circles. From behind a ring-shaped counter surrounding the librarian his assistants will give out and receive books, the endless chains of traveling trays dumping and taking on their loads inside of this ring. The four interior courts, open to the sky, are already completed as to their walls, which are faced inside with dazzling white tiles, for the purpose of reflecting the greatest possible amount of light through the windows. The book stacks have been completed and the sections of the building containing them have been roofed over. The masonry of the rotunda is all up, and the construction of the dome recently commenced. A new kind of glass is likely to be adopted for the skylight. Being formed on a sort of wire net, it cannot tumble and do damage if broken.

One of the most remarkable things about this building is that it will be finished at the appointed time, four years hence, and the cost of it will come within the appropriation, which was $6,000,000. Nine busts of famous writers will occupy niches in the window caps on the west front, looking toward the Capitol, but these literary celebrities have not yet been selected. The keystones of the window arches on the four faces of the structure bear sculptured heads representing the thirty-three types of races of mankind recognized by ethnologists. They were made from models and pictures at the National Museum, under the direction of Prof. Otis T. Mason.—*N. Y. Sun.*

A GOBLET OF INK CONVERTED INTO AN AQUARIUM.

Exhibit a goblet which is apparently nearly full of ink, and place it upon a table. In order to prove that the goblet really contains ink, partially immerse a visiting card in the liquid, and, on taking it out, show that it has been blackened. With an ordinary spoon, dip out some of the ink and pour it into a saucer. Then, having borrowed a ring, pretend to dip it into the milk, but really allow it to drop into the latter. Announce that you are going to make amends for your awkwardness, not by plunging your hand into the liquid, which would have the inconvenience of blackening it, but by rendering the ink colorless instantaneously. Take a white napkin or a large sized silk handkerchief and cover the glass with it. Upon removing the napkin or handkerchief, the glass will be found to contain clear water in which living fish are swimming. The hand may then be dipped into the liquid and the ring be taken out without fear.

Explanation of the Trick.—Take a goblet containing water and some fish, and place against the inner surface a piece of black rubber cloth, to which attach a black thread that is allowed to hang down a few inches outside of the glass, and to the extremity of which is attached a small cork. Of course, the thread and cork must be placed at the side of the glass opposite the spectator.

Fig. 1.

Fig. 2.

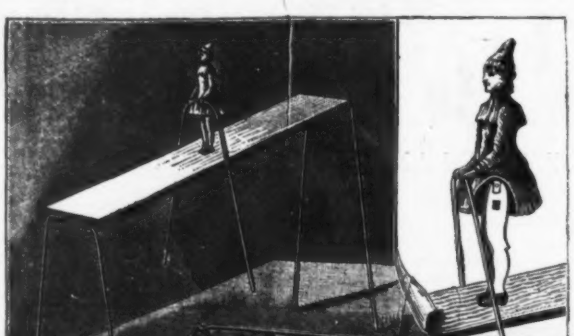
Cover the glass with the napkin, and, on removing the latter, grasp the cork, so as to raise it as well as the rubber cloth in the interior.

As for the card, that should have been previously blackened on one side for about three quarters of its length, and, after being immersed in the liquid, with the white side toward the spectator, should be quickly turned around so as to show the blackened side. As for the liquid taken out with the spoon, care should have been taken to previously fix in the interior of the bowl a few particles of aniline black soluble in water, by breathing on the spoon before introducing the powder, this serving to fix it. Then the water taken out with the spoon will be converted into ink, which may be poured into a plate or saucer.—*Le Magasin Pittoresque.*

A MECHANICAL TOY.

Among the new toys that made their appearance on New Year's, the one that we shall here call attention to seems to us to merit special attention, not on the part of children, who will treat it as they do their ordinary playthings, and amuse themselves with it today and throw it aside to-morrow, but rather on the part of lovers of ingenious combinations, giving, by very simple means, results that are truly curious.

The toy under consideration is a metallic puppet, which we figure herewith, and which holds in its hands, in the way of a balance pole, a metallic rod bent into the form of an inverted V. In consequence of the lowering of the center of gravity, due to the weight of the balance pole, the puppet stands erect upon any support whatever, as is done by all equilibrists; but, if it be placed at the top of the slightly inclined board which is sold with it, it will advance in putting each of its legs alternately forward, and imitate the motions of a person walking without bending the knees. A person who sees this little image for the first time hastens to take it in his hands in order to ascertain how the mechanism is arranged, and finds to his amazement that there is none—not the least spring, not even a taut rubber cord. There is nothing, absolutely nothing to make the legs move. The latter are jointed to a fixed horizontal rod, and a second rod, likewise fixed, placed beneath, passes through two square apertures in the legs, and limits the amplitude of their motions.



MECHANICAL TOY.

What, then, is the key to this enigma? How does the puppet succeed in so exactly reproducing the motion of walking? Very simply, by doing as is done by all of us: the indefatigable walker carries the weight of its body upon a single leg at the moment that it is about to put the other one forward. The axis of its body, in fact, does not rest in a vertical plane during the walking, and, in order to make it move forward upon its support, it is necessary at the outset to give it a slight stroke in a lateral direction. This stroke, amplified by the oscillation of the balance pole, causes the walker to lean alternately to the right and left.

Let us suppose that it leans to the left at a given moment. The entire weight of the body, bust and balance pole will bear upon the right leg, and, as the left foot no longer rests upon the wooden support, the left leg will be thrust forward through the effect of gravity, and will tend to assume a vertical position. At this moment a contrary oscillation occurs, causes the body to lean and to plant the left foot upon the board, and, the right foot being free in its turn, it is the right leg that makes a motion forward. This motion of the legs thus goes on indefinitely, and its duration will have no other limit than the length of the board. It is possible with rulers placed end to end to make a much longer track for it and, as may be seen, there would be nothing to prevent it from making the tour of the world upon a properly arranged inclined plane.

Although very amusing when it takes place in a straight line, the walking of our little man will become in the highest degree comical if we place him on the board in such a way as to make him move obliquely, and no longer in the axis of the board. After a few steps he finds himself at the edge of the latter, seems to divine the danger that threatens him, and pivots rapidly upon one of his feet in order to resume his oblique motion. This about-face is produced by the balance pole, the spacing of the branches of which has been calculated in such a way as to prevent falls. At the moment that the walker seems about to be precipitated into space, one of the branches of the pole strikes the opposite edge of the board and brings back the imprudent fellow to the straight road.

A GRATUITOUS NUMBER.

The day of publication falling one day earlier each calendar year has gradually antedated the issue of the Scientific American and Scientific American Supplement, so that in regular order the first number of the coming volume would naturally issue on Saturday, December 31.

To avoid the beginning of the new volume before the commencement of the new year, we have decided to give our mail subscribers the benefit of an extra number.

Instead, therefore, of stopping the Scientific American with issue No. 26, and the Supplement with No. 886, which would give the subscriber fifty-two numbers for the year, we shall, at considerable cost,

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mail to him a fifty-third number. We hope our mail subscribers will recognize our liberality in presenting them with an extra paper, and favor us with a prompt renewal of their subscription.

THE GREENWICH STEAM FERRY.

THIS ferry has already been in existence for some years, the steamers which are used in the service having been launched in 1888 from the yard of Messrs. Steward & Latham, of Millwall. The Greenwich ferry consists of a system of movable landing stages and of steamers, and the directors of the company are anxious that the county council should take over the ferry as it stands. They candidly admit that with the half hourly service at present in use, and with only one steamer employed, the ferry is not a remunerative business, but they plead that it is a service of great public utility, that it meets a widely felt want, and can now be acquired as a going concern at a moderate price. The engineers were Messrs. Clark & Standfield.

In the cut we give a sketch of the arrangements at one side of the ferry, and those at the other are precisely similar. The land approaches at each side are suitable for a large traffic, being 53 ft. wide, and at a height of 5 ft. 6 in. above Trinity high water mark; each road ends in an abutment wall 3 ft. thick at the top and 6 ft. thick at the bottom. On the river side of this wall is formed an inclined plane, with a slope of 1 in 10 toward the river. The slope consists of a solid bed of concrete 50 ft. wide and 3 ft. deep. The sides are made vertical, and go down to a depth of 5 ft. below the river bed. The concrete below low water mark was put in by skips from barges moored in the river. Upon the surface of the incline are fixed four lines of rails of 4 ft. 8½ in. gauge, 11 ft. 3 in. centers. The rails are of bridge section, 72 lb. per yard, bolted to transverse sleepers of wrought iron 6 in. by 6 in., which weigh 90 lb. per yard, and these are bolted to wrought iron longitudinal girders 8 in. by 6 in., and weighing 99 lb. per yard.

The incline goes down 145 ft. beyond the water's edge at ordinary low water of spring tides. Upon this railway are borne the landing stage and the carriages which convey the traffic between the landing stage and the shore. When these carriages are at the top of the incline they are exactly on the same level as the roadway, so that vehicles can be driven straight off the road on to the carriage. The landing stage is 70 ft. 2 in. long by 50 ft. wide, and the depth of the steel body is 6 ft. 6 in.; the depth over all is 7 ft. 8 in., and the total weight of each stage unloaded is 270 tons; each stage is supported upon thirty-two steel wheels carried in pairs by pivots, which thus distribute the load equally upon all the wheels.

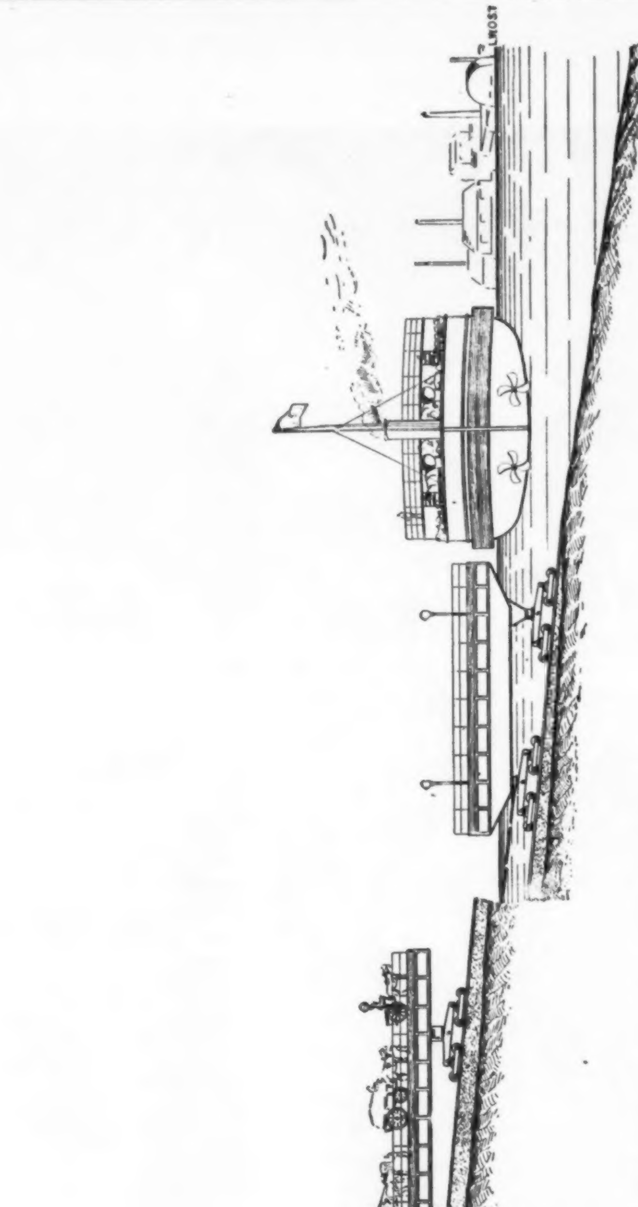
For each landing stage there are two traveling platforms, each 60 ft. long and 23 ft. wide; the clear width of the roadway between curbs is 21 ft., and the depth of the steel body is 2 ft. 7 in.; the weight of each carriage unloaded is 125 tons, and it is carried upon 24 steel wheels 18 in. diameter fixed under bogies similar to those in use on the landing stage. The framework of the traveling carriage is covered with wooden planks, and these again with wood paving, and four lines of tram rails, 72 lb. to the yard, are laid down in order that either rolling stock from the railway companies' lines or tram cars can be carried across. The landing stage is kept at a suitable level by means of the hauling gear, and the platforms pass to and fro with the vehicles and passengers as required. We may note that the carriage would float, if it got off the rails, with 50 tons of dead load upon it.

The hauling power at each side of the river consists of a pair of coupled engines with cylinders 16 in. diameter and 30 in. stroke. These give motion, by means of gearing, to a drum, upon which the wire ropes attached to the carriage are coiled. The gearing is so proportioned that the relative velocity of the engine piston to the hauling rope is about 3 to 1. The ropes are 4 in. in circumference, and made of the best steel wire, supplied and fitted by Messrs. Bullivant & Co., of Millwall; their breaking load is over 33 tons, and a large factor of safety is allowed. In order to reduce the work of the engines, the carriages are partly balanced by large weights of over 20 tons, which are hung in pits sunk to a depth of over 145 ft. below the level of the roadway.

Each pit is 10 ft. diameter at the top and 11 ft. 6 in. diameter at the bottom, and is lined with cast-iron tubing. The pulleys from which the weights are hung are so arranged that the weight travels one-third of the distance traversed by the carriage; the works have had, therefore, to be built very solidly to support the stresses.

A separate engine is used for the landing stage, having two cylinders 6½ in. diameter and 8 in. stroke. The deck of the stage is kept at the same height as that of the steamer, so that the motion of the stage up the incline is very slow; in fact, the piston speed is seventy-five times that of the landing stage, the reduction being brought about by worm gearing. The steam is supplied by three steel boilers of the locomotive type, at each side of the river; each can work up to 140 lb. per square inch, but in practice the pressure rarely exceeds 100 lb.

The whole of the machinery is placed underneath the roadway at the back of the abutment wall, the roadway itself being supported upon heavy girders. As we have remarked, the ferry company own two steamers, the Countess of Lathom and the Countess of Zetland. At present only the former is at work. Each is 466 tons displacement, divided by bulkheads, eight athwart the ship and three longitudinal. The vessels have no keels and are spoon-shaped at the ends. Each is 120 ft. long, 40 ft. beam, and 6·5 ft. draught. The deck accommodation for vehicles is 60 ft. long by 36 ft. wide, and about 1,300 passengers can be carried comfortably. Both ends of the steamers are alike, and are fitted with captains' bridges, steering wheels and telegraphs, so that they can be worked equally well in either direction. As there are twin screws at each end they can be easily steered, and can turn in their own length. Each vessel has two sets of compound surface-condensing engines of 300 indicated horse power. The high-pressure cylinders are 16·5 in. diameter, low pressure 33 in., and 24 in. stroke, lined with cast steel liners. The propellers are 6 ft. diameter, of cast steel, and iron guards are placed around each. In crossing the river all four propellers are used, and a balance rudder, 6 ft. by 6 ft., is fixed at each end of the vessel, and controlled by steam steering gear. Each steamer carries about 25 tons of coal. Besides the main engines, there are two sets of engines for working the air and circulating pumps, a set of engines for working the hydraulic machinery, and two pumping engines for supplying the boilers with water.



THE THAMES FERRY AT GREENWICH.

The bulwarks at the sides are fitted so that they can be lowered until their outer ends rest on the landing stage, and they then form the gangway between the landing stage and the deck of the steamer. These are worked by the hydraulic machinery alluded to above.

The difference in level between high and low water is twenty feet, so that these important works have

been rendered necessary to obtain a level crossing for vehicular traffic. For the last four months the ferry has been successfully worked under the superintendence of Mr. McIntyre. The completion of the works was delayed for a long time owing to a series of misadventures, which included the death of the first contractor, the failure of the second, and the death of the engineer.

We learn that, owing to carelessness on the part of one of the servants of the ferry company, the landing stage at the Greenwich side was not drawn up, during a night recently, at the proper speed. It was floated off the rails, and considerable damage was done to the wheels and under structure. Messrs. Clark & Standfield, however, inform us that an automatic arrangement was designed by them to prevent such an occurrence, but that it has not been yet applied by the ferry company.

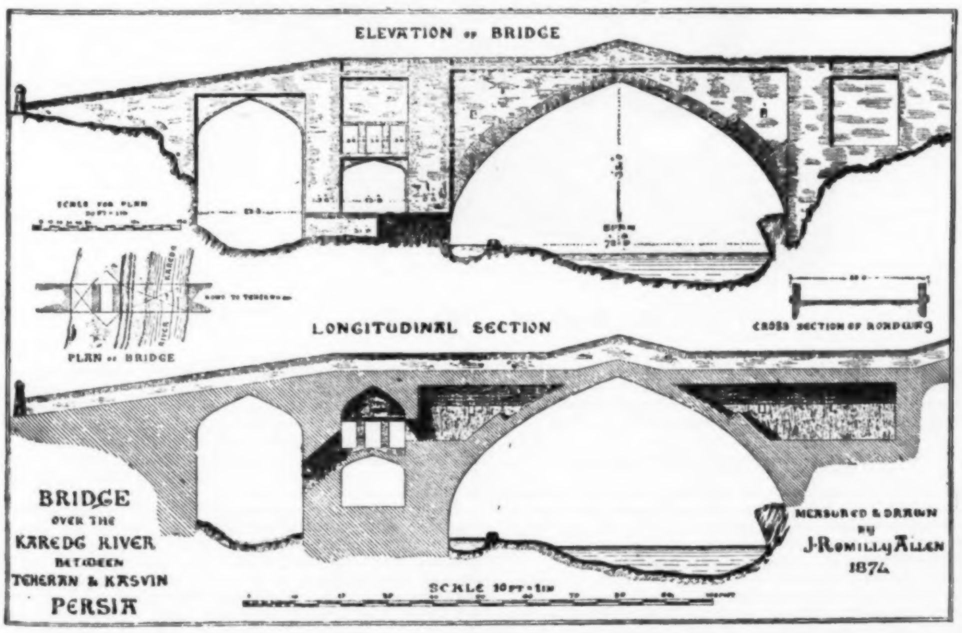
The directors state that at the end of October last the traffic had increased to 500 vehicles and 1,000 passengers weekly, and this with only a daylight service at intervals of half an hour, and they conclude that if the service were more frequent it would be much more largely patronized. As we previously stated, the tolls do not now amount to sufficient to make the venture remunerative.—*The Engineer.*

BRICK BRIDGES IN PERSIA.

LIVING in England, where the art of road making has attained so high a degree of perfection since the days of Macadam, it is difficult to realize that there are still countries, like Persia, where the whole of the traffic is conducted without the aid of wheeled vehicles of any description whatever. The great trade routes throughout Persia at the present day are simply tracks produced by the constant passing and repassing of long strings of camels or mules carrying bales of merchandise over mountain passes and across barren deserts. In a dry climate the services of the engineer may be dispensed with for improving the roads without any very serious inconvenience to the inhabitants if they are accustomed to riding and transporting their goods and chattels by means of pack saddles; but the crossing of rivers with strong currents is so formidable an obstacle to easy locomotion that the aid of the engineer must needs be invoked. This, perhaps, explains the curious anomaly that in Persia the art of bridge building should be so far in advance of the art of road making. Thus, the principal highway in Northern Persia—from Resht, on the Caspian Sea, to Teheran, the capital—is a mere trackway, but it possesses at least four brick bridges of considerable size.

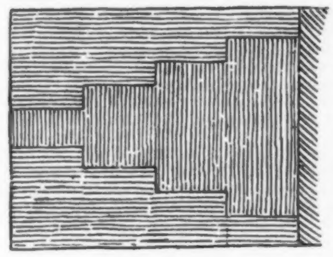
The distance from Resht to Teheran is about 200 miles. The first portion of the road from Resht follows the valley of the Sefid Rud (or White River) in a southerly direction as far as Menjil, where the river divides into two branches, one going northwest in the direction of Tabris, and the other, called the Shah Rud, going southeast toward Teheran. At Menjil the road turns, and after following the Shah Rud as far as Patchinar, commences to ascend the Kharzan Pass over the Elburz range of mountains. Having crossed the summit level, it descends toward Kasvin, situated in the great high plateau of Persia, the average level of which is 4,000 ft. above the sea. The remainder of the road from Kasvin to Teheran is along the plains at the foot of the Elburz Mountains.

The bridges are as follows: (1) over the Shah Rud (or Black River), a tributary of the Sefid Rud, into which it runs on the west side, between Resht and Menjil—a single pointed arch; (2) over the Sefid Rud at Menjil—seven pointed arches of unequal span; (3) over the Shah Rud near Pachinar—four pointed arches, two large and two small spans; and (4) over the Karedj River, which runs down from the Elburz Mountains between Kasvin and Teheran, and disappears in a gravelly plain.



Of the latter a measured drawing is given herewith, with details of its construction, as being perhaps the best typical specimen of those mentioned.

The Karedj is a rapid mountain torrent with precipitous rocky banks on each side. The bridge has two spans of 23 ft. and 72 ft. 9 in. respectively, the width of the central pier being 31 ft. 4½ in. The level of the top of the parapet above the water is 42 ft., and the level of the point of the arch of the larger span above the springing is 35 ft. The width of the bridge across the outside of the parapets is 30 ft. and the width of the roadway 26 ft. The size of the bricks of which the bridge is built is 10 in. by 10 in. by 2⅛ in. Twenty-four courses in height measure 6 ft. 2 in., the mortar joints being about ⅜ in. thick. The thinnest part of the arch in the middle is three bricks or 2 ft. 6 in. thick. It increases to five bricks, or 4 ft. 4 in. further on, and is nine bricks, or 7 ft. 6 in., next the abutments. The weight on the haunches of the arch is relieved by making three hollow cells or chambers, 4 ft. 9 in. wide and 12 ft. high, with pointed barrel vaulting beneath the roadway. The portion of the bridge over the abutment is also made hollow, there being a pointed barrel vault at the bottom going right through, and forming the floor of a chamber above. This chamber appears to be intended to be used for a temporary living-room for travelers. It is lighted by three windows at each end, and communicates with the cells above the haunches of the arch by an opening 4 ft. 6 in. high. The inner room is probably intended to afford sleeping accommodation. The living



ARRANGEMENT OF BRICKS AS SEEN ON UNDERSIDE OF ARCH.

room is approached by a staircase in the thickness of the wall leading up from the top of the pier. The Persian name for an upper chamber of this kind is "bala-khana," literally "a house up above."

The arrangement of the courses of bricks, as seen on the soffit of the arch when looking upward from below, is shown on the above sketch.

It will be observed that the courses go in two directions, one parallel to the central axis of the bridge and the other at right angles to it. This indicates the Persian method of constructing a brick arch, the chief object of which is to dispense as much as possible with a heavy centering in a country where timber is difficult to obtain and transport. The plan generally adopted is to set up a light centering, trussed so as to be sufficiently strong to support its own weight and a few rings of brickwork. After a single rib of bricks has been formed other bricks are dabbed against the first set, more being added next the abutment than in the center of the arch. The arch thus becomes self-supporting as the work goes on, like a cantilever bridge, and when the span has been completely covered over in the middle, the remaining courses at each side are completed with bricks facing in a direction at right angles to the former.

The mortar used for building in Persia is chiefly plaster of Paris, called "getch." It is mixed in shallow wooden saucers by boys, who hand it to the bricklayers without the aid of a trowel. The whole time the operation of building is going on a monotonous chant is kept up by the workmen, the words being as follows:

"Ajour bédé ajour."—A brick, give me a brick.
"Getché bédé getché."—Mortar, give me mortar.
"Getché bédé bé mân."—Mortar give to me.
"Diggêr yéké diggêr."—More, one more.

And so on with endless variations.

It is not easy to fix a date for any of the bridges in Persia in the present state of our knowledge, though very possibly historical documents exist at Teheran or elsewhere that would throw light on the subject.—*The Builder.*

SHEET iron is rolled so thin at Pittsburg iron mills that 12,000 sheets are required to make a single inch in thickness; light shines as readily through one of these sheets as through ordinary tissue paper.

THE EFFICIENCY OF SCREW PROPELLERS.

AT a recent meeting of the Institution of Mechanical Engineers, a paper entitled "Experiments on the Arrangement of the Surface of a Screw Propeller" was read by Mr. William George Walker, of Bristol.

Mr. Walker, in the course of his paper, said that the experiments which he proposed describing were projected and carried out during 1891 in connection with some trials of a screw propeller invented by the late Mr. B. Dickinson, of Messrs. Navin & Co., London. The primary object of the experiments was to ascertain the efficiency of screw propellers having the same diameter, pitch, and area, but different numbers of blades, and with the blades in various positions on the boss; in other words, of screw propellers differing from one another only in the arrangement of their virtual surface. Seven screws were tried, which he lettered A to G, all 38½ in. diameter, with bosses 7¾ in. diameter. They might be divided into two series—the first comprising five screws, A B C D E, and the second the two remaining screws, F G.

In the five screws in the first series the pitch was 64¼ in. and the aggregate developed area of the blades was 395 sq. in.; A had two blades, and B C D E had each four blades. In the two screws in the second series the pitch was 71¾ in. and the developed area of the blades was 381 sq. in.; F had three blades and G six. The blades were of forged steel, and were pressed by cast iron moulds into their required pitch shape. The bosses were of cast iron, and the blades were keyed on. If the blades, which were inclined slightly aft, were projected on a plane parallel to the axis, their leading and following edges would be parallel. The first series, A to E, consisted essentially of two double bladed propellers, each having its two blades opposite to each other. The stern shafting was made to receive both these propellers at the same time, one being placed immediately in front of the other and touching it. The forward screw was permanently keyed for the time being on the shaft; while the after screw had seven keyways in the boss, and was tried in seven different positions in reference to the forward screw; five of these positions formed the screws, A to E, and the two other positions were not considered in this paper.

The second series, F and G, consisted of two three-bladed propellers, which were fixed on the shaft in the same manner as those in the first series. The blades of the second series were narrower or shorter than those of the first; but the thickness at the roots and tips, and also the coefficient of surface friction, were practically the same in both series. Screw A was formed by bringing the leading edge of the after portion into contact with the following edge of the forward portion, thus forming a two-bladed propeller of the ordinary kind; the edges were a good fit, and two correct helicoidal blades were thereby formed. In screw B, the after portion was placed immediately behind the forward. Screw C was formed from screw A by turning the after blades forward in the direction of rotation, so that the after blades rotated in advance of the forward; the roots of the leading edges of the forward blades and of the following edges of the after blades were here in the same straight lines, parallel to the axis. In screw D the four blades were at right angles to one another, but this was not a propeller of the ordinary kind, because the alternate blades revolved in different planes.

Screw E was obtained by turning the after portion backward, in the contrary direction to the rotation, into a position just behind the forward portion, so that the after portion rotated immediately in the wake of the forward portion; this was not unlike an ordinary two-bladed propeller, but having a gap in the middle of the width of each blade. Screw F was arranged in a similar manner to screw A, thus forming a three-bladed propeller of the ordinary kind. In screw G the six blades were placed at equal angles with one another, and the alternate blades revolved in different planes. The yacht Ethel, on which the experiments were made, was owned by Mr. G. A. Newall, of Bristol. It was built and engined by his firm in 1886. It was 55 ft. long and 9 ft. beam; the mean draught during the experiments was 3 ft. 3 in., corresponding with a displacement of 18½ tons. The engines were vertical compound surface condensing of the ordinary marine pattern. The diameters of the high and low pressure cylinders were 7 and 14 in. respectively, and the stroke was 9 in.; the high pressure cylinder was placed forward; the piston rods were 1⅝ in. diameter.

The boiler was placed forward of the engines, and was 5 ft. diameter and 6 ft. 6 in. length; the working pressure was 100 lb. per sq. in. The trials were made on the Avon, on the regatta course at Saltford, about midway between Bath and Bristol. This was an exceptionally suitable place, as there was a perfectly straight run of nearly a mile, the sides of the course were parallel, and the width and depth of the water ample; it was also well shaded. The width was about 100 ft., the depth about 14 ft., and the sectional area of the river about 1,200 sq. ft., while the greatest immersed section of the yacht was 20·4 sq. ft. for the displacement of 18½ tons. The experiments were made on a base line of 3,400 ft., or 0·64 mile. Each screw was tried at six successive speeds, namely, 4, 5, 6, 7, 7½, and 8 miles per hour, as nearly as possible. For each speed the yacht was run over the course six times, three in each direction, and the mean was taken. The supply of steam was regulated by the throttle valve, which was locked for each experiment, the reversing gear being fully open. The working pressure in the boiler was constant at 100 lb. per sq. in. throughout the experiments, and the time was taken to a third of a second.

In order to insure having the same weight on board during the runs, the coal was weighed as it was used, and its weight was replaced at the end of each experiment. The total indicated horse power and the revolutions per minute were obtained exactly for the speeds of 4, 5, 6, 7, 7½, and 8 miles per hour, by plotting the experimental results and drawing fair curves through them, and then scaling off the quantities from the curves corresponding with these speeds. The equivalents of these speeds in knots were 3·47, 4·34, 5·20, 6·07, 6·51, and 6·94 knots. The results of the trials of the seven screws, together with their analysis, were set out in considerable detail in six tables which accompanied the paper. It would be seen, continued Mr. Walker, that screws C and G were the most efficient

in the first and second series respectively. Screws B, C, and D were exactly equal for all speeds up to six miles per hour; screw A was also equal to them for speeds up to five miles per hour. Screw C, the most efficient, ranged from equality at these speeds up to 2·02, 2·50, 1·45, and 4·24 per cent. greater efficiency at the maximum speed than the screws, A, B, D, and E respectively. Screw G was more efficient than screw F at all speeds except the minimum, when they were equal; the difference in efficiency was 1·53 per cent. at the maximum speed of 8 miles per hour. It was not unreasonable to suppose that, if a position of blades had been tried in the second series similar to that of screw C in the first, a greater efficiency would have been obtained.

It would be seen that at the lower speeds the results of the screws in each series were not affected either by the number or by the position of the blades. The blades of screws, B and E, evidently affected the water injuriously for each other at the higher speeds. The screws attained an efficiency of about 70 per cent. at the minimum speed, with a slip of about 22 per cent.; and afterward fell off, with further increase of slip. The screws were in themselves bad, inasmuch as their maximum efficiency should have been at the working speed of about 7½ miles per hour, but the screw space was insufficient to allow for more blade area; this, however, would not in the slightest affect the object of the experiments. From the figures accompanying the paper it would be seen that the sum of the mean pressures employed in the propulsion and slip of the screws was practically equal for the screws in each series, for the same speeds; in other words, the turning moments necessary to maintain the rotation of the screws, when going at the same speed, were equal. Therefore it might be clearly laid down that with screws of equal pitch and equal area of blades, when propelling a vessel at a certain speed, the pressure on the pistons would be equal, whatever might be the state of the water in which the screws worked, and the number of revolutions, and therefore the slip; for the revolutions would regulate themselves to the existing circumstances of the liquid fulcrum against which the blades acted.

That such was the case was seen from the fact that, while the pressures remained constant, the revolutions varied to a considerable extent. On comparing the pressure in the first and second series, they were found to vary in the direct ratio of the pitch, namely, as 1·00 to 1·12, thus showing that for equal speed the turning moment varied in the direct proportion of the pitch. This law was fully demonstrated in Mr. Blechynden's paper on the reaction and efficiency of the screw propeller (Northeast Coast Inst. of Engineers and Shipbuilders, 1887); in which he also said that the effect of the surface was the same irrespective of the number of blades into which it was divided. The results of the present trials, Mr. Walker went on to say, showed that the kind and aggregate extent of surface remaining the same, it was advantageous to increase the number of blades. Hence the blades would become proportionately narrower, and this was undoubtedly the cause of increased efficiency—that is, narrower blades were proportionately more effective than wider ones; for when the two-bladed and three-bladed propellers were divided respectively into four blades at right angles to one another (screw D), and into six blades (screw G), the slip was reduced for the same speed, with exactly the same steam pressure; consequently the efficiency was greater.

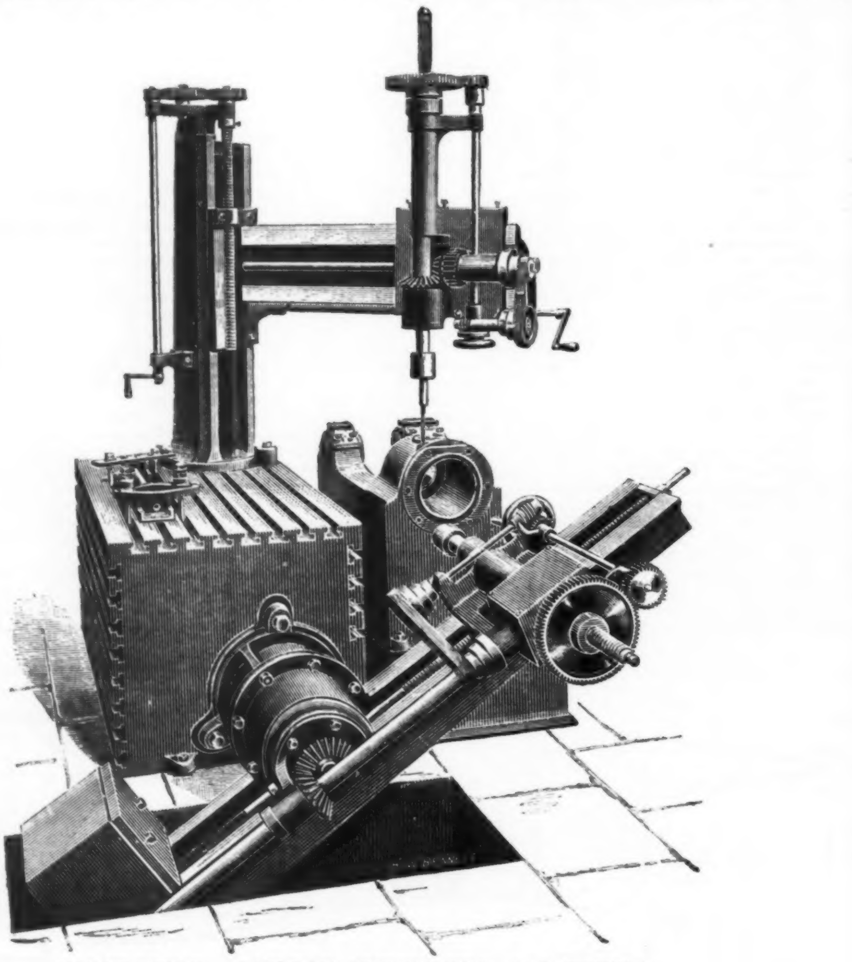
This conclusion appeared to be somewhat contrary to prevailing opinions; but the author was not acquainted with any trials of propellers having six or more blades. The above remark referred only to smooth water; in a rough sea the advantage of many blades appeared obvious. It did not seem difficult to find an explanation for the foregoing result. The normal pressure on a blade moving obliquely through water did not occur at the center of the width, but at a position about one-fourth or one-third of the width from the leading edge. If a sheet of paper or metal was moved through air or water with its surface inclined to the direction of motion, the leading edge would suffer considerable deflection compared with the following, and would tend to assume a position at right angles to the line of motion. The leading face of a propeller blade was thus more effective than the following. In a paper read before the Institution of Naval Architects, in 1890, Mr. Howden noticed this important fact, for he says, "It is evident that the efficiency of the blade decreases toward the after edge. The first six inches on the entering side are more effective than the last six inches on the after side."

It was thus chiefly by the leading side of the blade that the inertia of the water was overcome, and its acceleration produced, probably in the form of an impact, thereby giving the water a greater velocity than that of the screw itself. This would be a cause for apparent negative slip, the water flowing through the propeller faster than was accounted for by the product of the pitch and revolution. There must then be a region of reduced pressure on the working face of the blade. That there was a vacuum in the wake of a blade caused by the slip and by the body of the blade displacing the water, was proved by the performance of screw E; for with exactly the same steam pressure the revolutions increased to a marked extent, showing that the after section was exerting little or no thrust.

Mr. Walker also referred to the results of some trials that were made with propellers on the steamers Belle of Dunkerque and Herongate and on the tugboat Frank Stanley. These trials, he said, formed a strong corroboration of the somewhat more scientific trials at Saltford, demonstrating the superiority of narrow blades, which is obtained by increasing their number and arranging them on the principle of the screw C. The slip was thereby reduced, with even less blade area, as was seen from an examination of the results. The practical objections were overcome by making the propeller in two portions, which were more easily manufactured and handled, and could be fitted on without the often tedious necessity of withdrawing the stern shafting; all that was required in case of accident was to replace the injured portion. This principle applied advantageously to vessels of light draught; for by increasing the number of portions the diameter of the screw might be proportionately diminished, and the required blade area obtained, with a uniform pitch. That the steering was much improved was obvious, in consequence of the greater distribution of water discharged against the rudder, and the vibration was also reduced to a considerable extent.

IMPROVED RADIAL DRILL.

The drilling machine which we illustrate has been designed by Mr. J. H. Hamilton with a view to reduce the number of settings required in drilling any piece of work. Two drill spindles are used, one of which is mounted on a horizontal arm carried by a vertical standard in the usual way, while the other is mounted on an arm carried by a horizontal standard, so that the two drill spindles are always at right angles to each other. The arm for the horizontal spindle is balanced by a weight, so that it can easily be swung into any desired position. Since, however, the saddle is moved in and out from the pivot of the arm in the course of working the machine, it is necessary that the balance weight shall be moved in and out correspondingly in order to maintain proper balance. With this object the right hand traversing screw for the saddle is prolonged past the pivot and continued as a left handed screw under the balance weight, with which it is connected by a left hand nut. In this way on operating the traversing screw the drill, saddle and balance weight move in and out together, and the perfect balance of the arm is always maintained. Both drill spindles have an extreme range of 4 ft. 6 in. from the center of the pivot. The two drill spindles are driven by separate countershafts, and can be adjusted quite independently both as regards speed and feed. In our illustration the drills are shown ready to operate on an engine bed, while on the table a marine type connected-rod end is bolted, ready to have its eye bored by one spindle, while the other drills the bolt holes through it. The machine is manufactured by Messrs. Lee & Hunt, Nottingham.—*Engineering.*



IMPROVED RADIAL DRILLING MACHINE.

NEW YORK BUILDING STONES.*

All the stones used in building, under whatever name they may be known, are composed of a few elementary minerals; these are:

1. Silica or quartz.
2. Alumina clay or argillaceous matter.
3. Carbonate of lime.
4. Carbonate of magnesia.

Beyond these, except in crystalline rocks, the presence of other material is almost non-essential to the composition of stone, often accidental or adventitious, and usually injurious to the integrity of the mass. The ultimate chemical composition of a stone has little to do, as a general rule, with its character for durability; nor will a chemical analysis determine the value of a stone for building purposes.

PHYSICAL CONDITIONS OF THE AGGREGATES OF THE SEVERAL NAMED SUBSTANCES.

1. The silica or quartz may occur as a mechanical aggregation of particles of sand simply cohering among themselves, or by the intervention of some argillaceous, ferruginous, or calcareous matter acting as a cement; or lastly through a partial solution and cementation of the siliceous particles themselves. In the latter case, and where the mass is pretty purely siliceous, the process may have gone so far as to give a vitreous rock known as quartzite.

In many cases, however, the siliceous or arenaceous deposits present great inequalities of texture, from the aggregation of coarse particles or small pebbles among the finer materials, always to the injury of the strength and durability of the mass. Under certain conditions these mixtures become crystalline rocks of various character.

2. The clay, or argillaceous matter by itself or with a small admixture of silica, and often more or less of carbonate of lime, becomes a slate or shale rock in which argillaceous matter predominates is unfit for a durable building stone.

3. Carbonate of lime and magnesia, or the former alone, constitutes extensive beds of solid and durable stone, but which is often deteriorated by the presence of argillaceous matter. In many limestones, the mass consists of an aggregation of fine particles which have been deposited in the form of a fine calcareous mud. Other and often very extensive beds are visibly composed of the debris of shells and other organic bodies, cemented together by the finer particles of calcareous mud, or often by the partial solution of calcareous matter. Under the influence of subsequent conditions, these simple mechanical aggregations of calcareous matter or the calcareous magnesian deposits, become crystalline marbles of various colors.

In the purely siliceous stones or quartzites, the mass is too hard and brittle for easy working or comely shaping of the pieces; an admixture of clay or argillaceous matter being essential to the possibility of working stone whose basis is silica. When, however, this argillaceous material becomes excessive, the stone is liable to rapid disintegration from the action of the weather. While the silica absorbs but an extremely small quantity of water, the clay will absorb largely; and this, on freezing, will destroy the stone more or less rapidly. Some of the argillaceous sandstones on drying in a hot sun and then being suddenly wetted will crack and crumble into pieces. The same effect is often produced by the sudden freezing of large blocks which have been freshly quarried, and which still contain their water of absorption.

When the argillaceous matter is evenly and intimately mingled with particles of silica or quartz, and not in too large proportions, the stone will last a long time, and will disintegrate but slowly; but when the argillaceous material is in *seams* or *laminæ* of deposit, it is far more injurious, and every such seam in a block must sooner or later lead to its destruction. The manner of this is very simple. The clay seam absorbs water, and, holding it while freezing, the seam expands; if disintegration does not immediately follow, the seam is widened so that it admits more water on the next occasion; and so on successively with alternate freezing and thawing until an unsightly crevice is produced, which constantly widens and encroaches more or less on the adjacent parts till the stone is destroyed.

This condition occurs in the gray or light-colored freestone, as well as in the brown ones; but in the brown freestone or sandstone there is a further cause of destruction. The coloring matter, which is also in part the cementing matter of the grains of sand, is ferruginous, the siliceous grains are covered with peroxide of iron, and this substance is intimately combined with the argillaceous matter of the mass which cements the particles.

Experience has everywhere proved that the brown sandstones or freestones are not durable stones; their destructibility is not only due to the presence of argillaceous matter, but to the oxide of iron; for the gray

* Report New York State Museum.

or neutral-tinted stones, of the same composition otherwise, are much more durable.

As an evidence of the rapid decomposition of the red or brown sandstone when the siliceous element is deficient, we may sometimes find a large area, which, when broken up, decomposes so rapidly that it becomes in a few years an arable soil. The same is essentially true in some parts of the Medina sandstone. In order to demonstrate this fact, it is only necessary to examine any building of brownstone which has been erected for a period of twenty-five years. The New York State Library building is an example in point. The Capitol and Albany Academy have been longer erected, and were originally of better material than the library building. The basement of the old City Hall in New York is an example of the same kind, where the brownstone, from its inherent destructibility and from the presence of clay seams, presents a dilapidated appearance; and other examples might be mentioned. In Europe the same condition exists, and many old buildings of the red or brown sandstone are falling in ruin.

In the lighter colored sandstones we have mainly to guard against clay seams and too large a proportion of argillaceous mixture in the mass. Beyond this, the presence of iron pyrites is to be looked for. This mineral is present in so many rocks of this character, especially those with a bluish or greenish olive tint, that it is to be suspected in all such stones. It should be remarked, moreover, that iron pyrites (sulphuret of iron), when in visible grains, nodules or crystals, is not so dangerous or destructive to the rock as when disseminated in fine or imperceptible grains through the entire mass. This mineral, however, may be so disseminated and not prove entirely destructive, since in some stones it decomposes from the first exposure to the weather, staining the exterior of a rusty hue, and thus continuing to exude as an oxide of iron so long as any of it is reached by the moisture of the atmosphere; at the same time the free sulphuric acid unites with the lime or magnesia, if either be present, or to some extent with the alumina in the absence of the other substances; and this chemical change may sometimes go on for a long time, without seriously affecting the texture of the stone, producing no important result beyond the unsightly appearance. Generally, however, the decomposition of the pyrites produces the gradual destruction of the stone.

We have in the State of New York a class of argillaceous sandstones largely in use as building stones, and which are less known in any other State. They are of the character of rocks formerly known as "*Graywacke*," and the name might usefully be retained to designate the argillaceous sandstones of the Hudson River group, the Hamilton, Portage and Chemung groups. These beds of the Hudson River group are well known as *bluestone*, which is a compact argillaceous sandstone consisting of variable proportions of these materials.

The name *bluestone* is equally applicable to the heavy bedded compact arenaceous layers and the thin bedded slaty layers, which are largely used in the foundations of ordinary buildings. Much of the heavy bedded slaty rock of this character, which is quarried along the Hudson River valley, belongs to the Quebec group; but I am not at this time aware of any quarries in the same formation which furnished dressed building stone.

In the Hudson River group this rock occurs in many localities, in very regular beds which are cut by vertical joints presenting clean, straight faces, and are thus laid in the building. The composition of these stones (that is, in the proportions of silica and alumina) often varies in the distance of a few rods; but, if well selected and laid on its natural bedding, it makes a durable building material. Much of it, however, becomes stained from the decomposition of iron pyrites, which after a length of time either leaves the surface of a permanently rusty brown color, or the decomposition goes on till the rock crumbles or scales off in thin laminæ. Sometimes the faces of the joints are coated by thin laminæ of carbonate of lime, arising from the solution and infiltration of calcareous matter; and this forms a permanent coating, which resists all further change from atmospheric influences. It is of the greatest importance that these stones be carefully selected, or otherwise they soon become disintegrated.

The flagstones, so abundantly supplied from the upper part of the Hamilton group and lower part of the Portage group, are among the most enduring of the compounds of silica and alumina. The material is a fine-grained, compact argillaceous sandstone of a blue or bluish gray color, which, when free from seams, is scarcely influenced by the action of the weather. These beds are not only used for flagstones in most of the Atlantic cities, but in Albany, Troy and other towns along the river and elsewhere this stone is used for door steps and caps, window sills and caps, water tables, etc. The stone is strong and durable, sometimes slightly staining from the decomposition of iron pyrites, but rarely or never undergoing disintegration from that cause.

The bluestone of Malden on the Hudson River, which has of late come into use for ashlar, door steps and sills, pillars or pilasters, window sills and caps, water tables, etc., is obtained from some heavier beds in the Portage group along the base of the Catskill mountains. The stone has great strength and durability, wearing very slowly when used for steps, and possessing the great merit of retaining a certain degree of roughness of surface. The dark color may be regarded as the only objectionable feature.

In the central and western part of the State, the Portage sandstones are of a lighter color, usually more friable than those of the eastern outcrops. Many of the beds are of a greenish or olive gray color, occurring both in flaggy and heavier courses, which are easily dressed and present a very good appearance. The frequent presence of iron pyrites, causing both staining and disintegration, offers an objection to their extensive use. In the western counties, however, some of the beds are nearly gray, having lost the greenish or olive color almost entirely, and at the same time have less argillaceous matter in their composition, with scarcely a trace of iron pyrites. The stone from these beds has a very uniform gray color, a fine texture, and if quarried and dried before exposure to the frost, is a very durable stone.

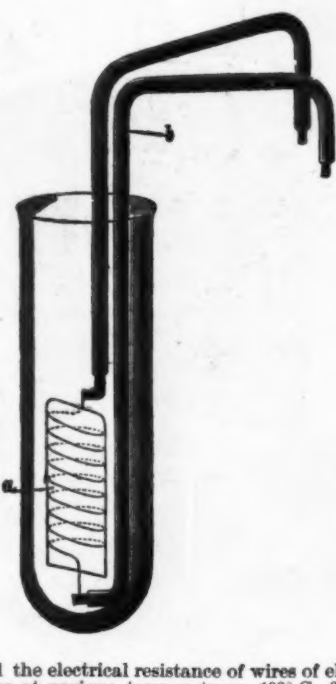
In Ohio, the arenaceous beds of the Portage group furnish the friable gray sandstone from which grindstones are largely manufactured, and from which more recently large quantities of building stone have been furnished. The cohesion of the particles is slight, and the stone is very brittle on first quarrying, but becomes stronger and harder on exposure, and, if properly selected, resists the effects of the atmosphere in a remarkable degree. The strong cohesion of the particles, therefore, is not always a requirement for durability, though it is for strength, either as resisting direct pressure or the effect of tensile force.

It should not be forgotten, however, that neither all the beds of this stone, nor all parts of the same bed, are uniform in texture, composition or durability, and it will not be surprising, if in its indiscriminate use it may sometimes prove unsatisfactory as a building stone.

The argillaceous sandstones of the Chemung group are generally or comparatively free from iron pyrites, and range in color from gray to olive or dark olive brown. When quarried and exposed to drying before freezing, they are comparatively durable stone; but they cannot be safely quarried during winter or exposed to freezing soon after quarrying. Building stones from this group, within the State of New York, have long been used, and new quarries have been opened at many points, though the stone has usually but a local importance. The more important structures erected from this stone are the buildings of the Cornell University, at Ithaca.

THE ELECTRICAL RESISTANCE OF PURE METALS, ALLOYS, AND NON-METALS AT THE BOILING POINT OF OXYGEN.

SEVERAL observers have studied the behavior of metals as regards electrical conductivity at low temperatures. In particular, MM. Caillet and Bouty (*Journal de Physique*, July, 1885) have made observations of the resistance and resistance change with temperature of various metals at —100° C., by the employment of liquid ethylene as a cooling agent. Wroblewski (*Comptes Rendus*, 1885, vol. ci., p. 161)



measured the electrical resistance of wires of electrolytic copper at various temperatures, 100° C., 20° C., 0° C., —100 C°., and gave, also, figures for the comparative resistance of the same wires at the critical point of nitrogen, the boiling point of nitrogen, and the temperature of the solidification of nitrogen.

The subject has recently been attacked in a more comprehensive way by Professors Dewar and Fleming, who, being in the possession of means for producing very considerable quantities of liquid oxygen, as well as liquid ethylene, have taken the opportunity of carrying out some investigations on the comparative electrical resistance of a number of pure metals, alloys, and non-metals, at the low temperatures obtainable by the evaporation of liquid oxygen at ordinary barometric pressures, and the ebullition of liquid oxygen under reduced pressures of about 20 or 30 mm.

Since liquid oxygen, as already pointed out by Professor Dewar, is a very perfect insulating fluid, it is quite a simple matter, if once sufficient of the liquid gas is obtained, to measure the electrical resistance of a wire or small rod of metal when immersed in it, and thus entirely at the same temperature as the evaporative liquid. A series of observations has accordingly been made by Profs. Dewar and Fleming on the specific electrical resistance of various metals, non-metals, and alloys over a range of temperature varying from + 100° C. to nearly —200° C., and although these investigations are as yet incomplete, the observations already made seem to be of sufficient interest to render it worth while placing them on record. This they have accordingly done in the October number of the *Philosophical Magazine*.

A number of small resistance coils were prepared, of different metals and alloys, in the following way: A thin rectangular sheet of mica, about 5 cm. long and 1 cm. or 2 cm. in width, had a number of nicks cut in the edges, and round this was wound loosely the wire whose resistance was to be determined. The ends of the wire were brought out through two holes in the mica and soldered to two stout copper terminal wires formed of high conductivity copper wire well insulated with India rubber. The ends of these terminal wires were bent over so as to dip into mercury cups (see figure). The resistance coil so formed could then be lowered into a test tube full of the liquid oxygen or other fluid by means of which the temperature of the wire was determined.

The majority of the wires used had a length of 50 or 100 cm. and a diameter of 0·003 inch. Their electrical resistance was measured by a Wheatstone's bridge, the coils of which were of platinum silver, and adjusted to read in B. A. units at 15·5 C. The balance was determined by the use of a highly sensitive mirror galvanometer, using the current from a single Helsen's dry cell.

The experiments were carried out in the Royal Institution laboratories, in a room which remained approximately at about 20° C. during the whole time.

A series of wires of pure metals was obtained, and also others of known alloys. Those examined included annealed platinum, palladium, nickel, gold (999·9 degrees fineness), silver, tin, aluminum, electrolytic copper, annealed iron; also platinum-silver, iridium-platinum, rhodium-platinum, palladium-silver. Wires of commercial materials were also mounted, *e. g.*, German silver, platinoid, tinned copper, tinned iron wire, commercial tin.

Careful measurements and observations were made, the observed resistance being reduced to a corrected resistance in each case. The results are set out in tables, which give the specific resistances for constant mass at the various temperatures of the different pure metals, alloys, and impure metals examined. The mean value of the various results is given, and temperature in degrees Centigrade placed over the number denoting the specific resistance in absolute electro-magnetic units.

By plotting these specific resistances out in a series of curves, Professors Dewar and Fleming found (taking the absolute temperatures as abscissæ) that all the lines of resistance are more or less curved lines, which tend downward in such a way as to show that if prolonged beyond —200° C. they would probably pass through or near the origin or absolute zero. These resistance curves can be divided into three classes:

1. Those of metals such as iron, nickel, tin, and perhaps copper, which are concave upward.

2. Those of metals such as gold, platinum, palladium, and probably silver, which are concave downward, toward the axis of temperature.

3. Those of metals such as aluminum, which are apparently nearly straight lines. In the case of a metal of the first class, such as iron, the resistance changes with the temperature, in such a way that the rate of change of resistance with temperature increases as the temperature increases.

In the case of a metal of the second class, such as platinum, as the temperature increases, the rate of change of resistance with temperature decreases.*

The most interesting fact which these experiments have brought out is the enormous decrease in specific resistance experienced by the perfectly pure metals when cooled to these low temperatures. Thus the electrical resistance of a given pure iron wire at —197° C. is only one-twenty-third part of that which it is at that at +100° C. In the case of pure copper the ratio of resistance is about 1 : 11 for the same change of temperature. The very smallest impurity greatly affects this decrease. This is shown by observations on pure nickel deposited by Mond's new process, and on some supposed pure nickel; the latter at —182° C. had a specific resistance of 6,737 electro-magnetic units, while the former, at the same temperature, gave only 1,900 units.

For the perfectly pure metals, it seems probable that, as the temperature is lowered toward the absolute zero, the specific electrical resistance decreases so that it either vanishes at the absolute zero or reaches a very small residual value.†

In the course of their experiments, Professors Dewar and Fleming found that the trend of the curve of specific resistance drawn with absolute temperatures as abscissæ seemed to give a good indication of the chemical purity of the metal.

The alloys were submitted to the same experimental treatment as were the metals. On charting the results it was found that the resistance lines were very nearly straight, with but little slope, not one-tenth that of the pure metals when the constituent metals of the alloy were chemically very different. But when these were chemically similar, the resistance lines plotted in terms of the absolute temperature slope down at a much steeper angle, but never in such a manner as to indicate that if prolonged they would pass through the absolute zero.

The impure metals behaved in a similar manner.

Among other facts of considerable interest, we may notice the following: We know that for temperatures above 0° C. carbon behaves like an electrolyte as regards change of resistance with temperature, *i. e.*, its specific resistance decreases as its temperature increases. Hence the behavior of carbon was examined when cooled down to —182° C. For this purpose Professors Dewar and Fleming used the filaments of incandescent lamps, taking the "treated" filaments of Edison-Swan lamps and the dense adamantine carbon employed in the Woodhouse & Rawson lamps. In both cases it was found that when cooled to this low temperature the specific resistance of the carbon continuously *increased* instead of decreasing, as do the metals.

Professors Dewar and Fleming propose to examine, at similar low temperatures, the electrical resistance of such non-metals as selenion and sulphur, and such substances as arsenic and antimony, which, though metals, have marked affinities with the non-metals. Also the behavior of such insulators as mica, glass, gutta percha, and India rubber. It is known that the resistance of these bodies decreases with rise of temperature. It is not improbable that for such bodies may be found a maximum resistance at the lowest attainable temperature, and that it may prove to be the case that pure non-metals approach a maximum specific electrical resistance and pure metal a minimum in

* This distinction between such metals as platinum and nickel, in respect of their variation of resistance with temperature, has duly been noted by Prof. C. G. Knott, *vide Proc. Roy. Soc.*, Edinburgh, vol. xxxiii. (1888), p. 187. The observations of Profs. Dewar and Fleming, taken with those of Prof. Knott, show that the distinction extends over a very large range of temperature, viz., + 300° C. — 200° C.

† Clausius made the suggestion, in 1858, that the electrical resistance of all pure metals is proportional to the absolute temperature. This appears to be approximately true for only a few metals, and not at all for others, but it yet remains not improbable that the electrical resistance of all pure metals would at the absolute zero be either *nil* or else exceedingly small.

proportion as the absolute zero of temperatures is approached. In any case, it is a matter of considerable interest to complete the examination of the change of conductivity with diminished temperature for all the metals in a state of the greatest chemical purity.

The most striking illustration of the effect of great cold on electrical conductivity as shown by Professors Dewar and Fleming is, perhaps, that at the temperature of boiling liquid oxygen, pure iron conducts electricity better than the present electrolytic copper does at ordinary temperatures.—*Electrical Review.*

ELECTRIC SNOW SWEEPER.

IN our cities and large villages, where getting about depends almost entirely upon street cars, every one knows how vexatious travel is made by a little snow. When horses are used as the motive power, the extra resistance offered by a few inches of snow on the track necessitates the use of one or more additional pairs of horses to each car; and when, as in the case of a heavier fall of snow, it becomes necessary to bring out the snow plow, it is not uncommon to see eight or ten what street railways often have to contend with. Our readers know very well how long it has taken for the first street car to work its way through after a storm. These sweepers, as already intimated, possess plenty of power to rapidly dispose of the snow and keep the tracks free and clear for continuous traffic. Our engraving shows in a general way the construction of the improved sweeper. It is provided with two diagonally arranged rotary steel brushes, one at either end. The one at the advancing end of the machine is the one used, the other remaining at rest until the sweeper moves in the opposite direction. The motors used for driving the machine forward on the track are of the usual waterproof type; and those used for driving the rotary brushes are similar to those used for driving the machine forward, except that they are wound to secure a normal speed of 1,200 revolutions of the armature per minute instead of 620. The brush or flier is driven from the motor through gears, all of which are inclosed. The flier motors are provided with rheostats by means of which the speed of the brushes is controlled.

These machines, which are built for strength and

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pairs of horses working hard to clear the track. Under conditions like these, the electric railway has peculiar advantages in having a large surplus of propelling power, as well as almost unlimited power for direct application to the work of clearing away the snow.

We give engravings of a snow sweeper which can move along the track at any desired rate of speed, and at the same time, with an independent set of motors, drive a set of rotary steel brushes with any amount of power and without being dependent in any manner upon the motion of the sweeper along the track. The machine which we illustrate was used during last winter in Duluth, Minnesota, Spokane Falls, Washington, and West Superior, Wisconsin, keeping the tracks clear, and permitting of uninterrupted travel. One of our views is a diagram showing the mechanical arrangement of the principal parts. The other shows the appearance of the machine when at work.

The experience of last winter has dictated but one or two improvements, which are being applied to the new machines now being built. One of these improvements consists in projecting the steel brushes, or fliers, farther beyond the steel plates, and providing an adjustable snow deflector for preventing the snow from being thrown too high in the air.

Our illustration, which is from a photograph, shows durability, have great power and are indispensable to electric street railways. They are made by the General Electric Company, of Boston, who will furnish to any one interested in the subject a fully illustrated bulletin of information.

THE ELECTRO-MICROGRAPHICAL EXAMINATION OF METALS AND ALLOYS.

ABOUT seven years ago considerable attention was attracted to a new method of examining iron and steel, based upon the behavior of these substances when dissolved at the positive pole of a Bunsen cell. This method was the outcome of some observations by MM. Osmond and Werth, and exhibits an ingenious combination of electricity, chemistry, and the microscope. A full account of it is given in the *Comptes Rendus* for 1885, vol. c., p. 450; but the following is a short *precis:* Small plates of cast steel, from 0·02 to 0·03 mm. thick, fixed to glass by means of Canada balsam, were treated with cold dilute nitric acid, when the iron dissolved, leaving a carbon compound behind.

A microscopical examination of the plates showed that cast steel possesses a cellular structure, the iron occupying the interior, and the carbide of iron the cell wall. The cells unite to form groups, which, in the thin plates, are seen to be separated by empty spaces, and, therefore, possess no walls. If a bar of cast steel is dissolved at the positive pole of a Bunsen cell in dilute hydrochloric acid, the residue, consisting of small spangles, preserves the original form. These spangles form a network, the meshes of which are filled with iron. If a polished surface of cast steel is etched with concentrated nitric acid, the dendritic structure of the cell groups is seen. In tempered steel, only simple cells are found. The interior of the cells is elongated by hammering, and the cell walls, which are but little extensible, more or less obliterated.

These researches, which have been fairly fruitful in result, have induced Mons. G. Guillemin to undertake similar investigations on non-ferruginous alloys. He finds that when the polished surfaces of alloys are attacked by dilute acids while under the influence of a feeble electric current (2 volts and $\frac{1}{16}$ ampere) they develop characteristics which are exceedingly useful for purposes of comparison, identification, etc. After this effect had been produced by the mutual action of the acid and the electric current, the corroded surfaces were examined microscopically.

The figures or etchings obtained are always the same for the same alloy, and they may be preserved for reference by photography.

The corroded surfaces consist of furrows more or less twisted, and separated by ridges which represent material that has been spared by the acid. Doubtless, at the moment of solidification the fluid metallic material had separated into many simple alloys of definite compositions which are unequally attacked by acids. This has been demonstrated by Mons. Riche (*vide Ann. de Chim. et de Physique*, xxx., 1873). By microscopical examination of the corroded surfaces they may at once be referred to a small number of classes. Thus, among bronzes and brasses we can distinguish those with a base of tin, the phosphor-bronzes, brasses containing less than 37 per cent. of zinc, "Muntz metal," and analogous alloys containing over 37 per cent. of zinc, aluminum bronzes, aluminum brasses, "Delta metal," "Roman brass," etc.

In white alloys with a base of tin, antimony and copper, known as "antifriction alloys," the presence of lead can easily be recognized, and even, with practice, something near the proportions.

In examining ingots of red copper from the same fusion, but of different pourings, those which are properly refined can be distinguished, while others in which the refining is not complete can be classed according to their degree of advancement.

It is known that the mechanical qualities of brasses and bronzes are much modified by the addition of very small quantities of aluminum or phosphorus. The chemistry of such "traces" has been much studied by Professor Roberts-Austen, while this physical influence, especially in regard to electrical conductivity, has received attention from the brothers Le Chatelier, Osmond and others. The presence of traces of these metals is at once recognized by the electro-micrographical method of examination, since the furrows have the forms of veins of marble, or, to use another geological illustration, of conglomerate, when aluminum is present; while phosphorus produces in bronze containing tin a characteristic image or etching resulting in appearance a fern leaf, which is seen more clearly near the outer margin than in the center, and which, no doubt, indicates differences of composition, due to different periods of cooling, as shown by Mons. Riche (*loc. cit.*)

The presence of 4 per cent. of zinc in a bronze has been discovered by Mons. Guillemin to mark the micrographic action of phosphorus. Further, for a given alloy, the "microgrammes," as he calls the images, indicate not only the circumstances of casting, but also the nature of the operations to which it has subsequently been exposed; whether it has been poured too hot or too cold; if it has been stamped or rolled, and if rolled, in which direction the power has been applied.

Altogether, this new method of examining alloys and metals is extremely elegant and instructive, while not the least remarkable feature about it is the manner in which chemical action is linked with electric current, and their joint effect determined by the aid of the microscope.—*Electrical Review.*

CONTRIBUTIONS TO THE STUDY OF DISINFECTION.*

PROFESSOR J. MASCHEK, whose name is already familiar to us through his investigations on water bacteria, has brought together in pamphlet form a large number of experiments on the relative value of various disinfectants and disinfectant processes. Since the introduction of Koch's methods, the study of the subject of disinfection has been immensely assisted, and it is now possible to take a more accurate measure of the extent to which micro-organisms are affected by different treatment, whether chemical or mechanical. The stimulus which it has thus received has not unnaturally drawn a large number of workers into this particular field of inquiry, and the literature is already very unwieldy.

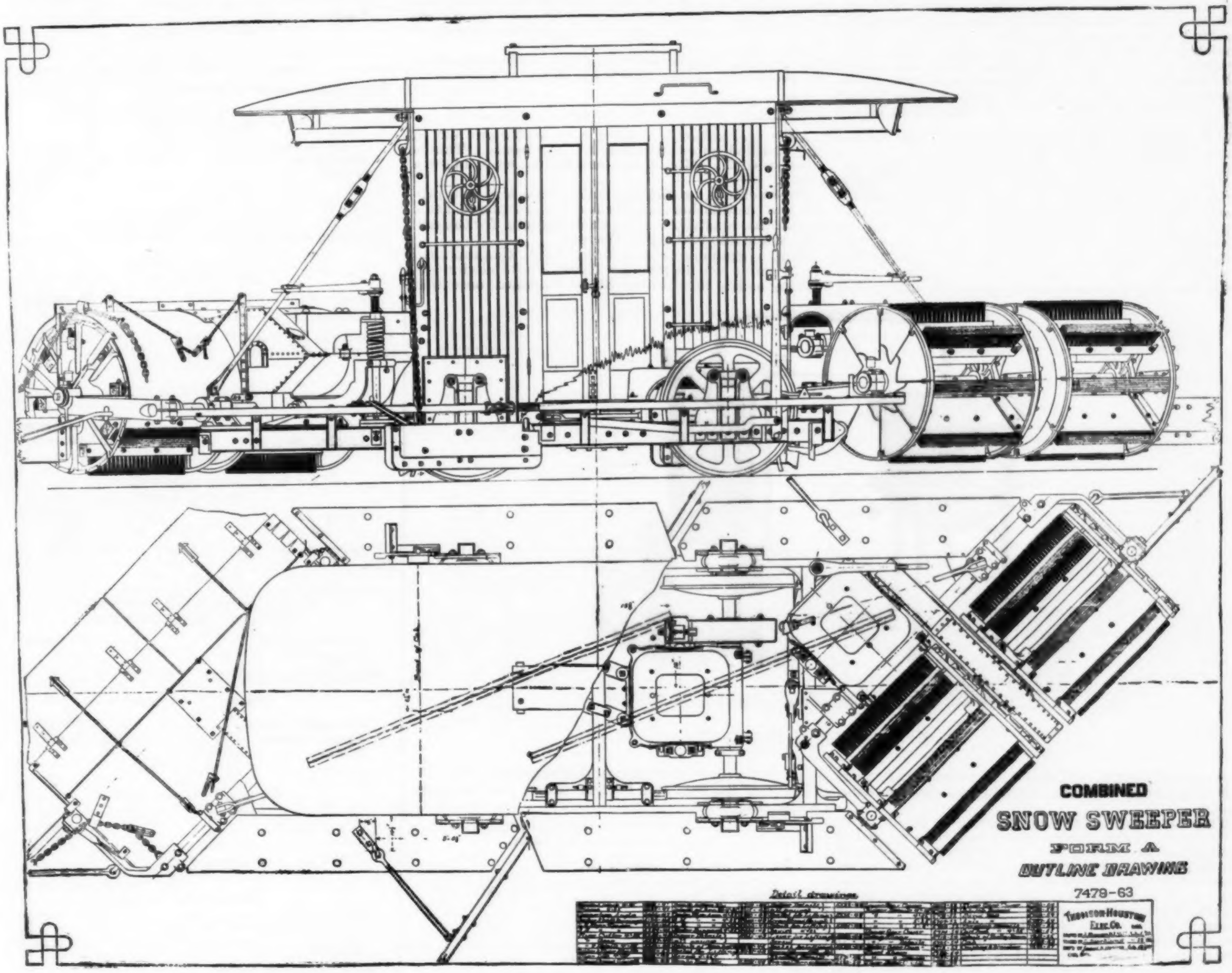
One of the principal difficulties which surround the study of micro-organisms is their individuality, their apparent idiosyncrasies, and this is not confined to closely allied varieties, but is found among members of one and the same species. Thus, the previous history of a micro-organism, the nature of the culture material used, the temperature at which the cultivation has been kept, the age of the growth, etc., are all points which have to be taken into consideration as likely to influence the behavior of the particular specimen under observation. This sensitiveness of bacteria may possibly to some extent account for the discrepant results which have been obtained by different investigators, although working in similar directions, which has rendered the accurate appreciation of the value of these results a by no means easy task. Again, what succeeds in a laboratory is not necessarily equally successful when carried out on a large scale, and it is this difficulty which has so frequently led to such disappointing results in actual practice.

Prof. Maschek has endeavored by a series of most arduous and painstaking experiments to throw a little more light on some of the problems of disinfection, and in gathering up his work has wisely abstained from attempting an exhaustive survey of the general literature, restricting himself to a brief introduction and particular reference to those investigations with which he has been more closely concerned. In the majority of the experiments the author employed Koch's well known method of sterilized silk threads, each of which was subsequently impregnated with pure cultivations of a number of different pathogenic micro-organisms. These were distributed in various parts of a room about 19 ft. long, 13 ft. wide, and 15½ ft. high, on the ceiling, walls, corners, floor, etc., while in some cases they were wrapped up in different materials, such as filter paper, muslin, linen, in order to imitate as nearly as possible the actual conditions under which the organisms might be supposed to be present in an infected room. In each case, after the application of the disinfectants under observation, these silk threads were submitted to plate cultivation, and in some instances their pathogenic properties were also tested by inoculation into animals.

The first elaborate series of experiments was made with the vapor of corrosive sublimate, which some authorities have recommended as an effective germicidal agent; but quite apart from the difficulty of getting rid of the poisonous crystals of corrosive sublimate which remained attached to various parts of the room, Prof. Maschek was not able to obtain satisfactory results, although every precaution was taken to insure success. In this respect his experiments differ from those of Konig, who confidently recommended its use for disinfection purposes. The effect of chlorine gas was next tested and applied both in the dry and damp state. The results were, however, far from encouraging, for even when employed in the damp state the spores were not destroyed. In connection with these experiments a very instructive instance is given of the signal failure which accompanied the use of chlorine in the Alexander Hospital in St. Petersburg, which was designed for receiving different infectious illnesses. Suspicion as to its efficacy was first aroused after its use in the disinfection of a ward in which diphtheria patients had been treated. This ward was afterward used for scarlet fever cases, and subsequently complications with diphtheria made their appearance, in consequence of which the ward was closed and disinfected with chlorine. (A ward of 900 cubic meters capacity being subjected to the chlorine gas evolved in treating 50 kilos. of chloride of lime with 65 kilos. of hydrochloric acid.) After the disinfection was completed, the ward was thoroughly cleansed and ventilated, and allowed to remain empty for seven months. On its being reopened for the reception of measles cases complications with diphtheria again arose, although the patients when taken into the ward were wholly free from diphtheria. The measles patients were therefore removed, and the ward was again disinfected with chlorine, only this time a much larger quantity was employed (135 kilos. of chloride of lime with 148·5 kilos. of hydrochloric acid), after which it stood empty for another seven months. Later on cases of small-pox were received into this ward, but diphtheria again appeared, the physician, two nurses, and an attendant being among those attacked, while complications with diphtheria again occurred among the patients. In consequence of this the unfortunate ward was once more closed and thoroughly disinfected with chlorine, and was reopened for typhoid fever patients; but all children's cases were rigorously excluded, in consequence of their particular susceptibility to diphtheria. After the adoption of this special precaution no further attacks of diphtheria were met with. It might, however, be urged that as regards infection of patients suffering from measles with diphtheria, the disease was possibly introduced from outside, and did not necessarily arise in the ward itself, were it not for the fact that there were three other wards in the hospital in which cases of measles were being treated at the same time, and no single attack of diphtheria occurred. Krupin, who is the authority for these facts, confirming the valuelessness of chlorine for disinfecting purposes, found that the spores of anthrax were not destroyed in a hospital ward after being exposed to the action of this gas for more than forty hours.

A large number of experiments were made with a view to determining the number of micro-organisms present on the walls of a room. For this purpose a small sterilized bit of sponge cut in the shape of a cube (of about half inch side) was used to rub down a measured portion (about four square inches) of the wall. The sponge was afterward placed in a tube containing sterile melted gelatine and rotated gently, so as to disengage all the organisms on its surface. The gelatine was then allowed to congeal on the sides of the tube, and after suitable incubation the colonies

* "Beitrage zur Theorie und Praxis der Desinfection, von Prof. J. Maschek." Im Selbstverlage des Verfassers, Leitmeritz.



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made their appearance, and were estimated in due course. It was found that the numbers present on the walls and ceiling respectively varied considerably. Near the floor the number was much greater than on the middle of the wall, while here again they were more abundant than on the ceiling. For example, on one of the walls, at a distance of rather more than an inch from the ground, as many as 2,871 microbes were found, which on the ceiling over a similar area only eighty-five were discovered. It was also noticed that those portions of the wall or ceiling which were exposed to currents of air from either the window or door exhibited generally a smaller number of bacteria than did places which were shielded from such draughts. Prof. Maschek further found that one rubbing was wholly insufficient to remove all the organisms from a given surface, and it was only after the process had been repeated five times that all bacterial life could be banished with certainty. Although the figures thus obtained are of interest by way of comparison, yet it is difficult to believe that they represent the *actual* numbers present. The accuracy of this method, originally devised by Esmarch, rests on the assumption that on placing the sponge in the tube of melted gelatine and rotating it gently (for if this were done violently the gelatine would froth, and the surface become covered with small bubbles, which would greatly interfere later with the counting of the colonies) all the organisms attached to the surface of the sponge would be removed. Now the sponge being left in the tube must necessarily obscure part of the gelatine surface; moreover, the interstices becoming soaked with gelatine, colonies would certainly develop within the sponge itself and escape detection, while it is quite inconceivable that gentle rotation would suffice to detach even all those organisms which are adherent even to the surface of the sponge.

Wall surfaces deprived of micro-organisms in the manner described above were subsequently sprayed with distilled water infected with different pathogenic bacteria, and after sufficient time had elapsed for these surfaces to dry, the effect of various disinfectants was tried. Numerous investigations are also recorded of the use of creolin, carbolic acid, and mixture of the latter with solutions of corrosive sublimate. The effect of exposure to high temperatures, in apparatus specially constructed for the purpose, has also been tried, while the disinfection of sewage matters with lime is also carefully considered, and a large number of experiments recorded with the typhoid and cholera organisms.

The following interesting account is given as an illustration of the success which can be achieved in disinfection on a large scale. An epidemic of diphtheria broke out in a small village in Germany and proved particularly fatal among the children; indeed so alarming was its progress that the burgomaster was led to suggest the disinfection of the whole village. A public meeting was held and the inhabitants were instructed as to the nature of the epidemic, and the possibility of checking it by the combined action of every household. Public funds were devoted to the purchase and distribution of the requisite disinfectants, and during three days the whole place is described as smelling of carbolic, while in all directions windows and doors were to be seen wide open, a very unusual sight in the country, and more especially in the month of February, when this occurred. The work of disinfection was carried on most systematically. Every article which could not be either washed or baked was treated with a 5 per cent. solution of carbolic acid. In short, no efforts were spared to thoroughly disinfect everything, and the result was that, although the epidemic before the commencement of this disinfecting crusade was steadily gaining ground, it suddenly stopped. This must be considered as a tribute to the sagacity and energy of the inhabitants; for, as Prof. Maschek points out, experience teaches us to expect a gradual decline, due to the possible weakening of the virus, so that toward the end of an epidemic the number of bad cases is lessened and recoveries are more frequent.

In conclusion the words of M. Duclaux may be appropriately quoted: "Les études sur les antiseptiques n'ont gagné que de s'encombrer de résultats qui se contredisent les uns les autres, et entre lesquels on ne peut faire un choix, précisément parceq'ils ont été souvent optenus en dehors des conditions d'une étude précise. Il faut donc abandonner cette méthode, scruter avec de plus en plus de soin la phénomène, faire de la science, en un mot." This "*faire de la science*" is precisely the spirit in which Prof. Maschek has carried out his experiments; the immense care with which they have been conducted, the ungrudging labor bestowed upon them, should render his results a most valuable contribution to the subject of disinfection. It is only to be regretted that they are not published in a form in which they would be more likely to become known and appreciated.—*Grace C. Frankland, in Nature.*

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. de Brevans, Chief Chemist of the Municipal Laboratory of Paris.

Chapter II. (*Continued.*)

SECTION III.—PERFUMED SPIRITS.

This name is given to alcohol which is charged with odorous principles. They are known in French as *alcoolats*. Alcoholates in pharmacy are simple perfumed spirits. Essence is a better term than perfumed spirit, and essence will be used throughout this section instead of spirit (French *esprit*).

Essences are of two kinds, simple and compound.

Simple Essences.—The apparatus for making aromatic essences is generally heated by a water bath or by steam (Fig. 35). This last method is admirably adapted for large works. To prepare simple essences, the substances, which have been previously cut, contused, or pulverized, as the case may be, are placed in the still. The necessary alcohol is then introduced, and after twenty-four hours of maceration, a certain quantity of water is added, and the distillation is started, and is only stopped when all the alcohol has passed over. The product should have an equal bulk as the alcohol which was put in, plus the amount of water added.

In general, the preparation of essences is as follows—the proportion of materials being about as follows:

Raw material	1 k.
Alcohol, at 85°	5 l.

After maceration, 2 l. 500 c. c. of water are put in and distilled, so as to obtain 5 l. of essence. This is mixed with 2 l. 500 c. c. and rectified so as to allow a product of 4 l.

The backings, or phlegm, which form the last products of distillation and rectification, are placed aside for another operation. The abbreviations for the metric system adopted are as follows:

Grm. = gramme or grammes; k. = kilogrammes; c. c. = cubic centimeters; l. = liters. For tables for converting metric into United States standard measures, see Scientific American Supplement, No. 747. Both the English and French names will be given where they differ.

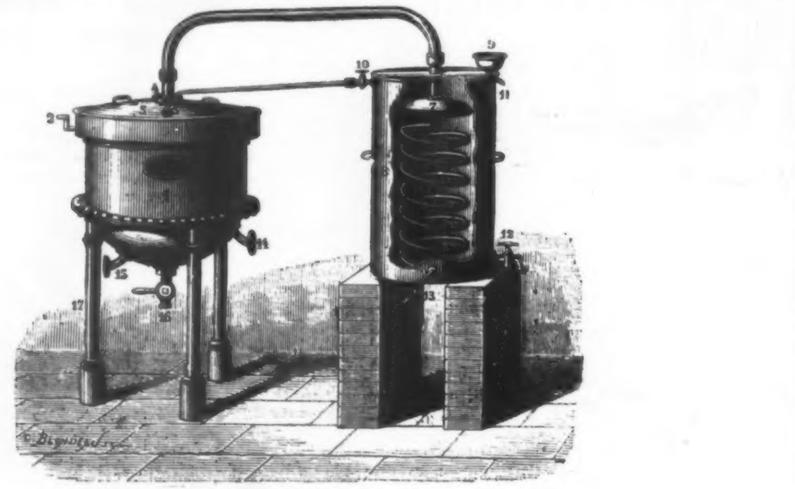

Fig. 35.—STEAM STILL.

Essence of Absinthe (large or small).
Esprit de Grande Absinthe.

Leaves and dry tops of the large absinthe or small	2 k. 500 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Aloes.
Esprit d'Aloes.

Socotrine aloes	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence Bitter Almonds.
Esprit d'Amandes Amères.

Bitter almonds	2 k. 500 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Amber Seed.
Esprit d'Ambrette.

Grain amber seed	1 k. 250 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Anise, star anise, angelica, and others are prepared as directed above.

Essence of Benzoin.
Esprit de Benjoin.

Benzoin in tears	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Bergamot.
Esprit d'Bergamote.

Bergamot	4 k. 500 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

* Continued from page 14159, Supplement No. 886.

Essence of Catechu.
Esprit de Cachou.

Catechu, Japanese, pulverized	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Cinnamon (Ceylon).
Esprit de Cannelle de Ceylon.

Pulverized cinnamon	300 grm.
Alcohol (85°)	10 l. 50 c. c.
Water	5 l.

Macerate for 24 hours, distill over an open fire, rectify the product with 5 l. of water over the open fire.

Essence of Cinnamon (Chinese).
Esprit de Cannelle de Chine.

Cinnamon, pulverized	300 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Prepare same as the Ceylon cinnamon.

Essence of Cardamom (large).
Esprit de Grand Cardamone.

Seeds of large cardamon (*Amomiun cardamomum*)	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Cardamon (small).
Esprit de Petit Cardamone.

Preparation same as above.

Essence of Caraway.
Esprit de Carvi.

Caraway seeds	1 k. 250 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Cascarilla.

Prepared in the same way as the above.

Essence of Cedrat.
Esprit de Cedrats.

Fresh rinds or skins of	60 cedrats
Alcohol (85°)	12 l.

Macerate for 24 hours, add 5 l. of water, and distill so as to make 11 l.; rectify with 5 l. of water.

Product: 10 l.

Essence of Celery.
Esprit de Celeri.

Celery seed	1 k. 250 grm.
Alcohol (85°)	10 l. 500 c. c.

Product: 10 l.

Essence of Lemon.
Esprit de Citron.

Fresh skins of	80 lemons
Alcohol (85°)	12 l.

Proceed in the same manner as for essence of cedrat.

Product: 10 l.

Concentrated Essence of Lemon.
Esprit de Citron Concentré.

Fresh skins of	160 lemons
Alcohol (85°)	12 l.

Same method as above.

Essence of Coriander.

Coriander seeds	2 k. 500 grm.
Alcohol (85°)	10 l. 50 c. c.
Water	5 l.

Product: 10 l.

Essence of Cumin Seeds.
Esprit de Cumin.

Cumin seeds	1 k. 250 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Curaçao.

Rinds of Curaçao oranges	2 k.
Alcohol (85°)	12 l.
Water	5 l.

Macerate for 36 hours.

Product: 10 l.

Essence of Candy Carrot.
Esprit de Doucus.

Seeds of candy carrot, from Crete	1 k. 250 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Fennel.
Esprit de Fenouil.

This is prepared in the same manner as essence of cinnamon.

Essence of Genepi.
Esprit de Génépi.

Leaves and tops of Alpine genepi	1 k. 250 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Ginger, Essence of Juniper.
Esprit de Gingembre, Esprit de Genièvre.

Same method of preparation as essence of genepi.

Essence of Cloves.
Esprit de Girofle.

Bruised cloves	60 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Proceed the same as for cinnamon.

Product: 10 l.

Essence of Hyssop.
Esprit d'Hysope.

Dried flowering tops of hyssop..	2 k. 500 grm.
Alcohol (85)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Lavender.
Esprit de Lavande.

Dried flowering lavender tops..	1 k. 250 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Mace.
Esprit de Macis.

Crushed mace	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Balm.
Esprit de Mélisse.

Picked and dried balm	2 k. 500 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Mint.
Esprit de Menthe.

Prepared in the same manner as the above, with the flowering tops of dried peppermint.

Essence of Mocha or Essence of Coffee.
Esprit de Moka.

Martinique and Mocha coffee equal parts mixed	1 k. 250 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Brown the coffee until it is of a fine yellow, then grind coarse and macerate for 24 hours. Distill so as to draw off 12 l., then rectify.

Product: 10 l.

Essence of Myrrh.
Esprit de Myrrhe.

Pulverized myrrh	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Apricot Seeds.
Esprit de Noyaux d'Abricots.

Kernels of seeds of apricots crushed	2 k. 500 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Nutmegs.
Esprit de Muscade.

Nutmegs, crushed	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Same mode of preparation as essence of cinnamon.

Product: 10 l.

Essence of Pinks.
Esprit d'Oeillets.

Petals of pinks, cleansed	2 k. 500 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Orange Flowers.
Esprit d'Oranger.

Orange flowers, cleansed	2 k. 500 grm.
Alcohol (85°)	10 l. 50 c. c.
Water	5 l.

Product: 10 l.

Essence of Orange.
Esprit d'Oranger.

Fresh peel of 100 oranges.	
Alcohol (85°)	12 l.
Water	5 l.

Product: 10 l.

Same operation as in making essence of lemons.

Essence of Orange (concentrated).

Fresh peel of 200 oranges.
Operation same as above.

Essence of Rosewood.
Esprit de Bois de Rhodes.

Shavings of rosewood	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Roses.
Esprit de Roses.

Fresh rose leaves	5 k.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Saffron.
Esprit de Safran.

Saffron (*du Gatinais*) 1st quality	300 grm.
Alcohol (85°)	10 l. 500 c. c.

Product: 10 l.

Essence of Sandal Wood.
Esprit de Santal.

Sandal wood broken up (lemon colored)	600 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Product: 10 l.

Essence of Sassafras.

Sassafras root cut fine, 600 grm. Same method of procedure as for sandal wood.

Essence of Tea.
Esprit de Thé.

Tea (*Pekao*)	100 grm.
" (Hyson)	100 grm.
" (Imperial)	200 grm.
Alcohol (85°)	10 l. 500 c. c.
Water	5 l.

Make an infusion in boiling water and let it stand in a closed vessel for two hours; add the alcohol, distill and rectify.

Product: 10 l.

Essence of Tolu.
Esprit de Tolu.

Balsam of tolu	600 grm.
Alcohol (85°)	10 l. 50 c. c.
Water	5 l.

Compound Essences.

Compound essences are numerous. They are prepared in the same manner as simple essences.

Compound Essence of Absinthe.
Esprit d'Absinthe Composé.

Absinthe, cleaned	1,000 grm.
Juniper, crushed	125 grm.
Cinnamon (Ceylon)	30 grm.
Angelica root	8 grm.
Alcohol (85°)	5 l.

Macerate for twelve days and distill. Draw off 3 l. 50 c. c. of the product. Redistill slowly to obtain 3 l. of product.

Compound Essence of Anisette (Ordinary).
Esprit d'Anisette Ordinaire.

Green anise	600 grm.
Chinese (star) anise	600 grm.
Fennel	200 grm.
Coriander	200 grm.
Alcohol (85°)	10 l. 500 c. c.

Mix the dry bruised materials, macerate for 36 hours. Put on 5 l. of water and distill so as to obtain 10 l. 500 c. c. To this product add 5 l. of water and rectify to obtain 10 l.

Essence of Bordeaux Anisette.
Esprit d'Anisette de Bordeaux.

Green anise	400 grm.
Chinese anise	100 grm.
Fennel	100 grm.
Coriander	100 grm.
Sassafras	100 grm.
Amber seed (*ambrette*)	25 grm.
Tea (imperial)	grm.
Alcohol (85°)	10 l. 500 c. c.

Essence or Elixir of Garus.
Esprit de Gorus (Codex).

Alcohol (80°)	6 l.
Socotrine aloes	5 grm.
Saffron	5 grm.
Myrrh	2 grm.
Cinnamon	20 grm.
Cloves	5 grm.
Nutmegs	18 grm.

Mix the bruised materials and macerate for four days in alcohol, filter, put in 1 l. of water and distill so as to draw off the spirituous portion.

Compound Essence of Juniper.
Esprit de Genièvre Composé.

Juniper	500 grm.
Caraway	60 grm.
Fennel	60 grm.
Alcohol (15°)	4 l. 500 c. c.

Bruise the materials, macerate for 24 hours in alcohol, add 1 l. of water and distill to obtain 4 l. 500 c. c. Rectify to obtain 4 l.

(*To be continued.*)

THE NEW BLEACH PROCESS.

THE *London Times* says: Instead of boiling his ammonium chloride with lime, Mr. Mond freezes it by means of an ammonia refrigerating apparatus, which by passing the gas through an endless cycle of condensations and expansions produces any required amount of cold. Treated in this way the ammonium chloride crystallizes out of the solution. It is dried and subjected to the opposite extreme of temperature. Somewhere about a red heat it sublimes and probably suffers temporary decomposition, the hydrochloric acid and the ammonia existing in the vapor as separate and uncombined gases. The vapor is passed over magnesium oxide mechanically arranged so as to present the largest possible surface. Then comes the characteristic reaction of the new chlorine recovery process. The magnesium oxide gives up its oxygen, which combines with hydrogen to form water. In place of the oxygen the magnesium combines with the chlorine of the ammonium chloride, and free ammonia is obtained and collected in the usual way. At this point, therefore, the account stands thus—bicarbonate of soda in the solid form, only needing to be heated to give soda ash; the ammonia used in the process wholly recovered, barring a percentage of waste, in its original gaseous state; and the chlorine wholly fixed as magnesium chloride. Now the reaction which produced magnesium chloride is exactly reversed. Hot air is passed over the chloride as hot chlorine was passed over the oxide, and as the chlorine of the ammonium chloride drove out the oxygen of the oxide, so now the oxygen of the air drives out the chlorine of the chloride. The free chlorine is passed over the caustic lime from the kilns after it is slaked with water, producing bleaching powder, and the magnesium oxide is left in its original condition ready to decompose a fresh batch of ammonium chloride. Thus the chlorine of the original brine is combined with the lime of the original chalk, the soda of the brine is combined with the carbonic acid of the chalk, the ammonia and the magnesium oxide employed in the process have been given back in their original forms, and nothing has disappeared except the coal which has furnished the heat required to effect the transformation.

ESTIMATING THE ACIDITY OF MILK.

By Dr. BOND.

DIRECTLY milk passes from the udder of the cow it exhibits traces of acidity, and this acidity goes on steadily increasing the longer the milk is kept, and it exercises a most important influence both on the value of the milk itself as an element of food and on its conversion into butter and cheese. It will be evident how essential it must be to the proper conduct of dairying that those who have to handle milk should be able not only to recognize the presence of acidity in it, but also to estimate with some approach to accuracy the *degree* of acidity which a given sample of milk or its products may have reached.

To this end Dr. Bond has devised a scheme in which he employs the following: (1) The neutralizer, which consists of a solution of potassium hydrate of such a strength that one unit volume (namely one drop) exactly neutralizes one volume of a solution of 7·875 grammes of pure, dry, crystallized oxalic acid in one liter of water. The solution of oxalic acid is exactly one-eighth the strength of the normal solution as employed for ordinary laboratory purposes, and it has been adopted because it has been found by experiment to give a solution of convenient strength for general dairy work. (2) A dropper, with an outlet of standard size, regulated to drop about one drop per second. With a view to providing a dropper which may be used by various persons so as to give comparative results, Dr. Bond has adopted a nickel plated brass tube having an external diameter of 17 B. W. G. (Birmingham wire gauge) as being most convenient for the purpose. (3) A glass well fitting in an air-tight manner in the neck of the bottle holding the neutralizer in such a way that the bottom of the tube nearly reaches to the bottom of the bottle, and is constricted to such an extent that the metallic tube of the dropper just fits into it and projects about half an inch below, when the dropper rests in the well tube. By this device the neutralizer is exposed to the air to the minimum extent, and at the same time could be extracted so as to be measured in drops. (4) A suitable bottle for the neutralizer. (5) The indicator, consisting of phenolphthalein. This substance, which, when in solution gives a full purple color in the presence of a most minute quantity of alkali, loses that color altogether when the alkali is neutralized by an acid; while in the presence of an acid it gives no color at all, when the acid is neutralized by the addition of an alkali, the purple tint makes its appearance. By taking advantage of the properties of this sensitive color reagent, and adding a minute quantity of it to any acid solution, and then gradually adding to the mixture an alkaline solution until permanent purple color is produced, we are able to recognize with ease the precise point when the acidity is perfectly neutralized. A few words will suffice to explain the process involved in making the test itself. The end of the sampling tube is inserted into the liquid to be tested, say milk, and by pressing the rubber capsule the proper quantity is taken up and squeezed into a glass. In the same way a charge of the *neutralizer* is taken by means of the dropping tube, and dropped into the milk, to which a minute quantity of the '*indicator* has been added, until a permanent purple color has been produced. The number of drops required for this purpose gives the number of *degrees of acidity* which the milk possesses.

No one who uses milk in the dairy, says Dr. Bond, can do so with any certainty of its condition and behavior unless he can estimate its acidity, and this it is claimed can now be done by the acidometer with as much ease and certainty as its temperature can be gauged by the thermometer or its weight determined by the balance.—*Chem. Tr. Jour.*

VOLUMETRIC DETERMINATION OF THE ALKALOIDS.

By L. BARTHE.

I HAVE ascertained that the best known alkaloids of vegetable origin are without action upon phenolphthalein, which they leave in the state in which it comes into contact with them; colorless if the medium is neutral or acid, rose colored if it has been rendered alkaline by a mineral base. Such are quinine, cinchonine, cinchonamine, cinchonidine, quinidine, morphine, codeine, cocaine, aconitine (amorphous or crystalline), strychnine, brucine, serine, vetarine, pilocarpine, duboisine, spartein. On combining this observation (made, I believe, for the first time) with the well-known property of the vegetable bases to turn red litmus blue, I have founded a general method for the volumetric analysis of the alkaloids.

If certain vegetable principles, hitherto regarded as alkaloids, do not react appreciably with phenolphthalein and litmus, it is doubtless because their properties are still imperfectly known, and that their chemical functions require accurate determination. For instance, narcotine, which, according to Pictet and Fluckiger, can scarcely be regarded as an alkaloid and which is without action upon phenolphthalein, litmus, and atropine, which with these substances behave like a weak acid.

However it may be, the alkaloid to be determined must be brought to the condition of a soluble salt by means of a mineral acid, *e. g.*, sulphuric acid, either in water or in a slightly alcoholic solution. An excess of acid does not prevent the reaction, but, on the contrary, rather promotes it. The presence of any salt of the alkaline or earthy bases, and even of a certain number of the heavy metals (*e. g.*, zinc), has no effect upon the process.

The following method of operation is very easily applicable to the determination of the alkaloids above mentioned, and also of the acids with which they may be combined.

DETERMINATION OF THE ACID.

We introduce into a beaker of Bohemian glass 1-1000 part of an equivalent of the alkaloid or of a salt of the alkaloid, adding 10 c c. of decinormal sulphuric acid in case of a salt, or 20 c. c. in case of a free alkaloid. We add 20 c. c. of neutral alcohol at 90 per cent. and three or four drops of an alcoholic solution of phenolphthalein. All the salts of the alkaloids dissolve in this acid alcoholic liquid. We then pour in decinormal potassa until there appears a faint rose-

colored tint of phenolphthalein. The number of c. c. of decinormal potassa used expresses all the acid, free or combined, existing in the mixture. The rose tint of phenolphthalein appears only when all the alkaloid is in the free state in the liquid; as a transparent solution if the alkaloid is soluble in weak, neutral alcohol, or as a precipitate if it is insoluble. We have thus a mixture indifferent to phenolphthalein, but alkaline to litmus in consequence of the liberation of the alkaloid.

DETERMINATION OF THE ALKALOID.

Into a second beaker of Bohemian glass we introduce 1-1000 of an equivalent of the alkaloid, or of a salt of an alkaloid, with 10 or 20 c. c. of decinormal sulphuric acid, and then some drops of a sensitive tincture of litmus. The color is then rendered blue again by means of decinormal potassa. The number of c. c. of the alkaline liquid employed in this second saturation represents merely the free acid. If this number is subtracted from the figure which in the foregoing operation measures the entire acid, it expresses exactly the quantity of sulphuric acid combined with the alkaloid in the state of a basic salt, and consequently the weight of the alkaloid itself. It is, in fact, sufficient to multiply the remainder from the subtraction by 1-1000 of the equivalent of the alkaloid in question. The factors are evidently:

For anhydrous quinone	0·0324
" cinchonine	0·0294
" codeine (H_2O)	0·0317
" morphine H_2O)	0·0303

—*Comptes Rendus*, vol. cxv., p. 512; *Chemical News.*

TEMPLES IN CENTRAL AFRICA.

AT a recent meeting of the Glasgow Archæological Society Mr. Robert M. W. Swan, member of the archæological exploration party of Central Africa, delivered an address on the "Ruined Temples of Central Africa—Zimbabwe, in Mashonaland: its archæology, astronomy and mathematics."

Mr. Swan, in the course of his address, said that ever since Europeans first reached Southeastern Africa rumors were current on the coast regarding great buildings in the interior of the continent; but Zimbabwe had not been visited by Europeans until Carl Manch discovered it twenty years ago. In 1890 some officers of an expedition which the British South Africa Company dispatched to occupy Mashonaland sent home a description of the ruins, which excited so much interest in this country that a scientific expedition was fitted out.

The ruins are distributed over the country between the Zambesi and Limpopo rivers, but the most important of them are at Zimbabwe. All the buildings are rounded in form, and are made of small, unhewn blocks of granite, about twice the size of the bricks, and without mortar. They are of three degrees of excellence in workmanship, the first and oldest being the best built. These have carefully leveled courses, and the walls, which are solidly built throughout, are constructed on a curious mathematical plan. Buildings of the second class have the stones forming the facing of the walls fairly well laid, but in the interior the walls are not solidly built, nor are they built on any mathematical plan. The third class of buildings are such as are constructed by the Kaffirs of to-day. The buildings of the first two classes bear on their walls decorations of a geometrical kind, which are oriented toward the sun when it is either rising or setting at one of the solstices. In the first class of buildings these decorations are most accurately oriented, but in the second class much less so. Three cults had been followed in the temples, namely, the worship of the sun, as is shown by these decorations, the worship of the stars and one of the grosser forms of nature worship.

The most interesting ruins are those of Zimbabwe itself, and he would only deal with them. On Zimbabwe Hill they found temples and fortress combined in one. There are two temples, and on a great cliff over one is poised a huge stone, which seems to have been an object of worship. The position of the great temple 680 yards away in the plain below has been fixed relatively to this stone, for the principal altar in that temple is placed due south of the stone with great accuracy, and the outer wall has been pierced by a dooorway, so that the stone could be seen from the altar itself.

The purpose of this arrangement was to enable stars to be observed from the altar over the stone at their culminations or meridian passages. The great temple is constructed on a series of circular curves, and measures about 250 ft. in its greatest diameter. Its walls are about 25 ft. high and 15 ft. thick. Most of its interior arrangements are destroyed, but one little temple and the two towers remain. These towers were important symbols in nature worship. The unit of measure used was the common cubit. The diameter of the greater tower is exactly ten cubits, and this is also the circumference of the lesser one. Thus the ratio of the diameter of a circle to its circumference was expressed in the relative proportions of the two towers, and this is a key to the construction of the whole temple and of all the best built temples in Mashonaland, and of all the curves forming the contours of the towers themselves. The position of the towers also determined the orientation of the temple. In all the best built temples in Mashonaland a point true north of the center of every curve of the walls had been marked by a doorway or by an erect monolith, and the purpose of this arrangement was to enable the meridian transits of stars being observed. Only stars of the northern hemisphere were observed, and this points to a northern origin for the people.

Stars were never observed on the horizon, but generally on the meridian, and in this the astronomical methods used at Zimbabwe differ from those of the Egyptians, Phœnicians, Chaldeans, and ancient Indians; for these peoples always observed stars on the horizon, and rarely if ever on the meridian. The only known people whose methods of astronomical observation may have resembled those used at Zimbabwe are the early inhabitants of South Arabia, and they probably were the builders of Zimbabwe. Of their history little is known, but at a very early period indeed they seem to have been a highly civilized race, and to have had an alphabet earlier than the Phœnicians. Their power and commerce was probably greatest and most extensive before the expedition of Queen Hatason, of the eighteenth Egyptian dynasty, who conquered them, and it was probably before her time that Zimbabwe was built.

The Minæans seem then to have been the ruling people, but later, in Solomon's time, it was the Sabeans who dominated. The objects found in the excavations at Zimbabwe may be Phœnician, and probably are, but there is nothing to connect them clearly with the original temple. The positions in which they are found rather led him to infer that they belong to a later period. They seem to point to an occupation of the temples by the Phœnicians, perhaps about the time of the expedition sent by Pharaoh Necho in the sixth century B. C., when the temples were already in ruins, and these Phœnicians probably rebuilt some of the walls which are of the second period. It is quite clear that the original walls could not have been built by the Phœnicians, for the style of their workmanship is clearly distinct, and they are no parallel to the Phœnician remains at Hagiar Kim in Malta. It is hoped that more light may yet be thrown on the question when we have the results of further excavations at Zimbabwe.—*The Architect.*

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